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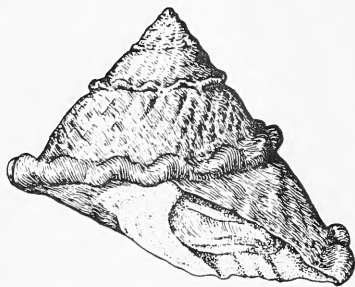
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THE WESTERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT



Santa Clara, California

June 28–July 1, 1978



Volume 11

The Western Society of Malacologists

Annual Report

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Issued: JAN 9 1979

Editorial Board, 1978-1979

Dr. Eugene Coan, *Editor*

Mr. Michael G. Kellogg, *Assistant Editor*

Mrs. Carol C. Skoglund, *Treasurer & Assistant Editor*

Dr. A. Myra Keen, *Past President*

Dr. Peter N. D'Eliscu, *Past President*

Dr. Hans Bertsch

The **Annual Report** of the Western Society of Malacologists is based on its yearly meeting. Distribution of the **Annual Report** is free to regular and student members who are, at the time of issue, in good standing. Membership dues are \$7.50 and \$3.00 for students. Others of a regular member's family may join for an additional \$1.00; each family receives only one **Annual Report**.

The Western Society of Malacologists has issued two **Occasional Papers** — No. 1, "Sea Shells of Tropical West America: Additions and Corrections to 1975" by Myra Keen & Eugene Coan; and No. 2, "A Catalogue of Collations of Works of Malacological Importance" by George E. Radwin & Eugene Coan. Each was priced at \$2.50. The first is now out of print; the second is still available.

Correspondence regarding membership and orders for additional or back issues of the **Annual Report** or the **Occasional Papers** should be addressed to the current W.S.M. Treasurer, Mrs. Carol C. Skoglund, 3846 E. Highland Ave., Phoenix, AZ 85018.

When full-length papers are included in the **Annual Report** or **Occasional Papers** they are reviewed by two members of the Editorial Board in addition to the Editor.

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NOTICE OF THE 12th ANNUAL MEETING OF THE WESTERN SOCIETY OF MALACOLOGISTS

The 1979 meeting of the Western Society of Malacologists will be held jointly with the American Malacological Union in Corpus Christi, Texas, August 5th to 11th. Meetings will convene at La Quinta Royale, a new motor inn one block from the shoreline. Field trips, workshops, and symposia on Gulf of Mexico mollusks and life histories of Mollusca are scheduled. A call for contributed papers, on these and any other malacological topics, will be issued early in 1979. Information about the meeting is available from Mr. Barry Roth, W.S.M. President, Department of Geology, California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118.

Applications for membership should be sent to: Mrs. Carol C. Skoglund, Treasurer, 3846 E. Highland Ave., Phoenix, AZ 85018. Dues: regular membership—\$7.50; additional family members—\$1.00 per person; student membership—\$3.00. Regular and student members receive the **Annual Report** containing the published proceedings of the annual meeting.

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PROGRAM SUMMARY

Wednesday, 28 June

12:00-3:00	Registration
3:00-5:00	Session I
6:00-7:30	Dinner
7:30	Slide presentation by Phillip W. Clover

Thursday, 29 June

8:00-9:00	Breakfast
9:00-11:30	Session II
12:00-1:00	Lunch
1:00-1:20	Group Photograph
1:20-5:00	Session III
6:00-7:30	Dinner
7:00-9:00	Executive Board Meeting
7:00-10:00	Auction

Friday, 30 June

8:00-9:00	Breakfast
9:00-11:30	Session IV
12:00-1:00	Lunch
1:00-3:00	Session V - Symposium on the Pulmonata
3:00-4:00	General Business Meeting
4:00-6:00	Reception
7:00-9:00	Banquet — Dr. Eugene Coan, "The Life and Times of James Graham Cooper"

Saturday, 1 July

8:00-9:00	Breakfast
9:00-	Checkout and visits to California Academy of Sciences

SUMMARY OF MINUTES, EXECUTIVE BOARD AND ANNUAL BUSINESS MEETINGS JUNE 29 & 30, 1978

The meetings were presided over by President Peter N. D'Eliscu. The minutes of last year's meeting, as contained in the Secretary's book and summarized in the 1977 **Annual Report**, were approved.

Treasurer Carol Skoglund reported that a total of \$1,714.46 was on hand as of June 1st.

Dr. Myra Keen read a letter from the Nominating Committee, which was chaired by Mrs. Helen DuShane. The following slate of officers for 1978-79 were approved unanimously:

President	Mr. Barry Roth
First Vice President	Dr. Vida C. Kenk
Second Vice President	Mrs. Carol C. Skoglund
Secretary	Mr. William D. Pitt
Treasurer	Mrs. Carol C. Skoglund
Members-at-Large	Mr. Michael G. Kellogg Mr. David R. Lindberg

A discussion was held concerning the proposed joint meeting with the American Malacological Union at Corpus Christi, Texas, from August 5 to 11, 1979.

President Peter D'Eliscu gave the report of the committee he appointed to review the need for a Committee on Budget or Finance. A motion to accept the committee's recommendation that a Committee on Budget or Finance *not* be created was

passed. (The consensus was that the Executive Board should carry out these functions.)

President D'Eliscu read a letter from James T. Carlton in which he resigned as chairman of the Student Grants Committee. Dr. Vida C. Kenk was appointed to succeed him.

A new By-Laws article, Article XI, covering publications, as circulated to the membership prior to the meeting and as amended by the Executive Board, was adopted.

The editor, Eugene Coan, reported on the costs of the 1977 **Annual Report**. The production of 350 copies of the 1978 **Annual Report** was authorized, with the understanding that this will cost approximately \$1,000. The existing exchanges with other organizations for the **Annual Report** were approved, as were the release of approximately 40 gratis copies. It was decided that 5 complete sets of the **Annual Report** will also be distributed to selected academic libraries not possessing such sets.

The president announced that a list of past presidents has been put in the gavel case to replace the lost metal plate. He also announced that Mrs. Edith M. Abbott has accepted the job of historian for 1978-79.

Salle S. Crittenden, *Secretary*

TREASURER'S REPORT

July 1, 1977 to July 31, 1978

On hand, July 1, 1977

\$2,119.07

RECEIPTS

Dues	1975	1 regular	\$	5.00	
	1976	3 regular		15.00	
	1977	17 members		75.00	
	1978	135 regular		1,012.50	
		18 family		18.00	
		19 student		57.00	
				<u>57.00</u>	\$1182.50
Publication sales					
		Annual Reports			
		1 @ \$2.50		2.50	
		24 @ \$5.00		120.00	
		1 @ \$7.50		7.50	
		Occasional Paper #2			
		21 @ \$2.50		52.50	182.50
				<u>52.50</u>	
Auction					632.85
Donations					
		Student Grant		10.00	
		Unassigned		22.75	32.75
				<u>22.75</u>	
Interest					54.54
Conference					net
				<u>40.55</u>	\$2125.69
					<u>\$4,244.76</u>

EXPENSES

Annual Report Vol. 10, with 10-year Index					
		Typesetting	\$	600.00	
		Printing		779.05	
		Postage		76.00	
		Editor postage, phone		23.06	\$1,478.11
				<u>23.06</u>	
Postage, supplies					
		President		28.44	
		Secretary		35.20	
		Treasurer		67.40	
		Historian		42.07	
		Auction, 1977		21.15	
		Auction, 1978		10.40	204.66
				<u>10.40</u>	
Dues		AMU 1978		<u>10.00</u>	\$1,692.77
					<u>\$2,551.99</u>

On hand, July 31, 1978

Valley National Bank, Phoenix, Arizona

Savings Account #3690-7755	\$2,342.35
Checking Account #104-7193	166.59
Accounts receivable	
Conference	\$40.55
Dues (in part)	2.50
	<u>43.05</u>
	<u>\$2,551.99</u>

Carol Skoglund, *Treasurer*
Auditing Committee:
Forrest L. Poorman
Clifton L. Martin
Sally Bennett

GEORGE EDWARD RADWIN (1940–1977)



George Radwin was born in Rockaway, New York, and as a child spent much of his time swimming, diving, and collecting the marine life of that area. After he graduated from Brooklyn College, he and his wife, Rhoda, moved to Florida State University, where he completed a masters degree, with a thesis on the muricid gastropods of the northeastern Gulf of Mexico. His doctoral work was at George Washington University in Washington, D.C., and his dissertation was on the western Atlantic Columbelloidea.

He, his wife, and their two sons moved to San Diego, California, when he became Curator of Marine Invertebrates at the San Diego Natural History Museum, and he remained there until his sudden and unexpected death at the age of 37 in 1977.

He will be remembered for his many published works on the Columbelloidea and the Muricidae. He served as an officer of the San Diego Shell Club, and he was President of the Western Society of Malacologists during the important first joint meeting of the W.S.M. with the American Malacological Union at San Diego in 1975. He also taught courses in marine biology on both the university level and in an adult education program. His hobbies included collecting cacti and making pottery.

His presence will be missed at the annual meetings of the Western Society of Malacologists.

[Adapted from a biography prepared by Anthony D'Attilio and published by the San Diego Shell Club in *The Festivus* 10 (2): 11–24, Feb. 1978. A bibliography of his work on mollusks is included therein. Photograph by Robert Robertson.]

PAPERS PRESENTED TO THE ELEVENTH ANNUAL MEETING: TITLES AND ABSTRACTS

INTERTIDAL MARINE MOLLUSCA OF SOUTHEAST FARALLON ISLAND, SAN FRANCISCO COUNTY, CALIFORNIA

David R. Lindberg

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University of California
Santa Cruz, California 95064

James T. Carlton

Department of Geology
University of California
Davis, California 95616

Three distinct island groups near the edge of the continental shelf and lying roughly parallel to the mainland coast of central California make up the Farallon Islands — North, Middle, and Southeast. Southeast Farallon Island (34°41'57"N, 123°00'02"W) is situated approximately 50 km offshore and is the largest island, approximately 26 hectares in area. It is the only inhabitable island of the group.

The earliest records of marine mollusks from Southeast Farallon Island are those of P. P. Carpenter, who examined a small collection of shells received in England about 1858. Other early workers, including W. M. Gabb, J. G. Cooper, Rev. J. E. Rowell, C. H. Townsend, J. S. Arnheim, J. W. Blankinship, and C. A. Keeler, all either collected there or studied collections made by others. Carpenter received shells from both Cooper and Rowell and reported many new records from the island in his 1864 report on western North American mollusks. William H. Dall received Farallon shells from the early photographer C. E. Watkins, who collected a large suite of shells while on the island in the 1880's. The most extensive collections of marine mollusks from Southeast Farallon were made by G. D. Hanna and A. G. Smith in 1949 and by the Farallon Research Group from 1973 to the present.

Over 120 species of intertidal marine mollusks occur on the island. Although some workers have characterized the island's marine fauna as being predominated by cold, northern elements, our study has revealed instead numerous warm-water, southern species. Interesting aspects of the molluscan fauna include the apparently continuous presence, since 1864, of *Conus californicus* Reeve, 1844, far north of its typically reported northern distribution limit of Monterey Bay, California; the apparent absence of two specialized algae-dwelling acmaeid limets, *Notoacmea inessa* (Hinds, 1842) and *Collisella instabilis* (Gould, 1846), in spite of the presence of the necessary laminarian algae; the absence of certain gastropods commonly associated with the surfgrass *Phyllospadix*, particularly *Notoacmea paleacea* (Gould, 1853), *Alia carinata* (Hinds, 1844), and *Lacuna marmorata* Dall, 1919; and the habit of another limpet, *Collisella scabra* (Gould, 1846), of eroding deep, complex home scars in the bivalve *Mytilus californianus* Conrad, 1837.

Also unusual is the role of sea birds in the accumulation of marine mollusks on Southeast Farallon Island. *Macrarenia*

farallonensis (Smith, 1952) was originally collected from sea bird guano. Other species, including *Megasurcula carpen-teriana* (Gabb, 1865), *Antiplanes catalinae* (Raymond, 1904), *Cancellaria cooperi* (Gabb, 1865), and a species of *Nucula*, collected on the surface of the island are all thought to have been brought there by diving birds. Shore birds, including the black oystercatcher and turnstones, feed on intertidal mollusks, which we have collected from their nests or pellets.

[This work was conducted under the auspices of the Farallon Research Group, Oceanic Society, Fort Mason, San Francisco, California 94123.]

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ASPECTS OF THE ECOLOGY AND BEHAVIOR OF THE OWL LIMPET, *Lottia gigantea* Sowerby, 1834

William G. Wright

Moss Landing Marine Laboratories
Moss Landing, CA 95039

Natural movements and behavior of 15 owl limpets, *Lottia gigantea* Sowerby, 1834, located on an intertidal cliff in west Santa Cruz on Monterey Bay, California, were observed from a bosun's chair lowered by block and tackle from a wooden frame to a position 3 to 5 m above the limpets. Further observations were obtained by direct manipulations of moving limpets.

Movement occurs only when the substrate is wet, mainly during high tides. The percentage of such a period during which an individual limpet actually moves varies from 0% to 70%. Movement during these times is difficult to predict, but there is a clear tendency for smaller limpets to move at low tides, especially at night when the substrate stays wet longer. All limpets show a marked tendency to cease movement during periods of high wave shock. This is previously unreported, and suggests that extreme wave shock may have a strong effect on *L. gigantea*'s ecology.

Previously reported territorial behavior is confirmed. Although rarely occurring in nature, encounters between equal-sized limpets may last for as long as 18 hours. In addition to the territorial response, small *L. gigantea* also perform a distinct escape response. Among these small *Lottia*, the "fight or flee" decision is apparently mediated not by the size or species of limpet eliciting the response, but by the location of the small *Lottia* in respect to its own home scar and the territories of other *L. gigantea*. A small *L. gigantea* that is grazing far from its home scar on the territory of another *L. gigantea* will rapidly escape from any limpet with which it is placed in contact. When the same limpet is near its home scar, however, it reacts to the same stimulus with an aggressive territorial response. A more precise definition of the criteria for these behaviors ("near," "far," "small," etc.) is presently under investigation.

THE ASSOCIATION BETWEEN AN ENDOPARASITIC RHABDOCOEL (FAMILY FECAMPIDAE) AND THE NUDIBRANCH *Aeolidia papillosa*

Beth Brewer

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Members of the population of *Aeolidia papillosa* (Linne, 1761) collected under Pier II of Monterey Municipal Wharf contain an endoparasitic rhabdocoel. Comparisons of the life cycle and anatomy of this rhabdocoel with those already described indicate that it is a new genus as well as species in the family Fecampidae. No infection occurs in nudibranchs within 3 m of the surface. Infection increases with depth. Some samples of larger, deeper dwelling nudibranchs exhibit approximately a 50% infection rate. Frequency of infection increases with increasing size of the nudibranch; infection rarely occurs in nudibranchs of 5 mm or less. The rhabdocoel may be located anywhere in the host's haemocoel. Penetration of the individual host tissue is negligible. Loss of or reduction in size of gonads rarely occurs. Although the host dies on emergence of the parasite in the laboratory, such deaths are probably uncommon in the field. Damage to the population by the parasite thus appears to be negligible. The nudibranch has a semi-annual life cycle. Other populations of this species have annual life cycles. This may be a response of the nudibranch to limit the effect of a biotic factor, such as a predator or the rhabdocoel parasite.

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FEEDING ECOLOGY AND LIFE HISTORIES OF AEOLID NUDIBRANCHS FROM ELKHORN SLOUGH, CALIFORNIA

John W. Cooper

Moss Landing Marine Laboratories
Moss Landing, California 95039

The influence of predatory nudibranchs upon the hydroid *Tubularia crocea* (Agassiz, 1862) was investigated for one year in Elkhorn Slough, Monterey County, California. Fourteen species of nudibranchs were collected with *Tubularia* on subtidal fouling panels. *Cumanotus beaumonti* (Eliot, 1906); *Coryphella cooperi* (Cockerell, 1901); *Coryphella trilineata* O'Donoghue, 1921; a possibly undescribed species of *Coryphella*; and *Hermisenda crassicornis* (Eschscholtz, 1831) feed upon *Tubularia* polyps and gonophores. *Catirona alpha* (Baba & Hamatani, 1963), *Tenellia adspersa* (Nordmann, 1845), and *Trinchesia albocrusata* (MacFarland, 1966) feed upon *Tubularia* stolons amidst the basal tangle of stems.

Polyp autotomy in *Tubularia crocea* was observed in October 1977. No epidemic polyp shedding by colonies was apparent in response to nudibranch or artificially conducted predation. *Tubularia* polyp removal experiments and field observations revealed that colonies possess regenerative ability throughout the year. Clipped colonies were able to

regenerate polyps in 18 days at 17–18°C. This suggests that nudibranch predation alone is not responsible for the destruction and subsequent disappearance of *Tubularia crocea* colonies in Elkhorn Slough.

In 36 hour feeding rate experiments, adult *Coryphella trilineata* consumed 13 polyps per predator in low predator density replicates. In high predator density replicates, *C. trilineata* consumed about 5 polyps per predator.

Tenellia adspersa was successfully reared through its life cycle in the lab. Hatching occurred after 4–5 days at 15°C. Juveniles reached maturity in about 31 days when reared upon *Bougainvillea glorieta* Torrey, 1904. Thus, the life cycle was completed in 35–36 days.

In order to forward our knowledge of life histories of these mollusks, research should be conducted to elucidate the reproductive strategies of aeolids and their response to fluctuations in food supply, rather than concentrating upon embryological data.

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A POPULATION STUDY OF THE NUDIBRANCH *Chromodoris godeffroyana*

Scott Johnson

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University of Hawaii
Honolulu, Hawaii 96822

Hans Bertsch

Curator, Marine Invertebrates
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San Diego, California 92112

Chromodoris godeffroyana (Garrett, 1877), a nudibranch species never before reported from Hawaii, occurs at Magic Island, Oahu, in numbers sufficient to do long-term population studies. Each animal's color pattern is unique and allows for repeated individual recognition; there is no need to use artificial dyes, notches, or other devices that would disturb or damage the animal or change its appearance.

Preliminary data indicate that the animals are almost always found in pairs, change partners frequently, and move in random patterns over relatively short distances. The study is being continued to examine further elements of the abundance, "promiscuity," and movement patterns in this *Chromodoris godeffroyana* population.

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MARGINELLIDAE AND OTHER MOLLUSKS FROM SENEGAL

Phillip W. Clover

P.O. Box 83
Glen Ellen, California 95442

[A slide show; no abstract submitted]

A REVISION OF THE LAMELLARIIDAE (MOLLUSCA: GASTROPODA) OF THE NORTHEASTERN PACIFIC

David W. Behrens

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77 Beale
San Francisco, California 94105

Eastern Pacific members of the Lamellariidae, a group of tunicate grazing gastropods, have not received recent attention in molluscan literature. This is due to their cryptic nature and existing nomenclatural confusion. A review of this group has revealed that some diagnostic features are more useful and reliable than others. Specimens of all known northeastern Pacific species were examined, and field observations have supplemented examination of museum material. New diagnostic criteria will be proposed in a more formal treatment of the group. Some species are being allocated to genera other than *Lamellaria*, and several taxa are considered to be *nomina dubia*. Descriptions and diagnoses, where required, will be given for the following species:

Lamellaria Montagu, 1815

L. perspicua (Linnaeus, 1758)

L. inflata (C. B. Adams, 1852)

L. diegoensis Dall, 1885

Marsenia Gray, 1850

M. stearnsii (Dall, 1871)

M. rhombica (Dall, 1871)

Marseniopsis Bergh, 1886

M. sharonae (Willett, 1939)

Distribution, zoogeography, and ecology, including food, and habitat preference, have been studied.

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A REVIEW OF THE WEST AMERICAN SPECIES OF THE GENUS *Crassinella*

Eugene Coan

Research Associate

Department of Geology
California Academy of Sciences
Golden Gate Park
San Francisco, California 94118

The bivalve genus *Crassinella* contains a number of fossil and Recent American species in both the Caribbean and Panamic faunal areas. Barry Roth and I have just completed a review of the Recent eastern Pacific species. The genus is a member of the Crassatellidae, differing from *Eucrassatella* partly on the basis of its relatively small size. They are also unique and rather peculiar in morphology, for not only are the most common species opisthogyrate (with posteriorly pointed beaks), but other shell features also make their anterior end appear to be the posterior and their left valve appear to be their right. (A number of workers have described new species with front and back and right and left reversed from the way it ought to be.)

Our conclusions with regard to the West American species are as follows:

The most common and wide-spread species is *Crassinella*

pacifica (C. B. Adams, 1852), which is a close relative of the Caribbean *C. lunulata* (Conrad, 1834). It occurs from Orange County, California to Peru. *Crassinella branneri* Arnold, 1903; *C. mexicana* Pilsbry & Lowe, 1932; and *C. quintinensis* Manger, 1934, are synonyms.

The unique *Crassinella oregonensis* Keen, 1938, described from a single specimen from Coos Bay, Oregon, appears to be based on a valve of the Atlantic *C. lunulata*, which was probably brought with oysters from the Atlantic coast.

Crassinella ecuadoriana Olsson, 1961, is a valid species, occurring from La Paz and Mazatlán to Ecuador.

We are recognizing from the Recent fauna for the first time *Crassinella nuculiformis* Berry, 1940. It occurs from Isla Cedros and throughout the Gulf of California to Ecuador. A synonym is *C. clementia* Pilsbry & Olssen, 1941.

Crassinella adamsi Olsson, 1961, is a valid species and lives from Mazatlán to Ecuador.

We have a new species from the coast of central Mexico. It occurs from Bahia Banderas to Acapulco.

Crassinella varians (Carpenter, 1857) is a small but common species occurring from Bahia San Juanico on the outer coast of Baja California, throughout the Gulf of California, and south to Ecuador. *Crassinella goldbaumi* Jordan, 1936, and *C. haylocki* Pilsbry & Olsson, 1941, are synonyms.

Finally, we are recognizing in the Recent fauna *Crassinella coxa* Olsson, 1964, proposed for material from the Pleistocene of Ecuador. It is very close to *C. varians* but is separable on a number of points. It occurs from Punta Rompiente on the outer coast of Baja California and Isla Coronados in the Gulf of California to Colombia.

All of these species occur in fairly shallow water, the mean depths for the seven Recent species being 24.5, 13, 20, 20, 31, 28, and 76.5 meters. Most species appear to prefer mud or sand substrates, whereas others are more characteristic of gravel or rocky bottoms.

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RECENT WORK ON FRESHWATER BIVALVES OF THE GENUS *Mytilopsis* IN NORTH AND CENTRAL AMERICA

Dan C. Marelli

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San Francisco State University
San Francisco, California 94132

Since the original systematic work on the American members of the bivalve family Dreissenidae, little work has been done on the group. The family is represented in the New World by one genus, *Mytilopsis*, with seven species. All occur in fresh to brackish subtropical to tropical waters. *Mytilopsis* is of particular importance in light of its potential as a fouling organism, and I am working on a taxonomic revision of the species in this genus. Recently, interest in *Mytilopsis* has increased, and work is being conducted on several species. Some data on *Mytilopsis* populations in the Hudson River estuary is available, but the distribution of most species and their natural histories is largely unknown.

FLUORESCENCE IN FOSSIL MOLLUSKS

Wayne S. Barnett

Department of Geology
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Fossil fluorescence has been recorded for the past 50 years, but application of the technique has been limited to a very few cases. Fluorescent specimens have been found world wide from Cretaceous to the present. Causes of fluorescence in mollusks is unknown, although recent theory suggests organic compounds and inorganic elements. All theories are complicated by lack of detailed analysis of shells, poor preservation, and lack of uniformity of fluorescence. Best data at present indicate fluorescence is biologically controlled. Fossil specimens recently collected commonly fluoresce on the exposed side and not on the buried side. Reasons for this phenomenon could be exposure to ultraviolet radiation, heat, and/or natural bleaching.

Recording fluorescence by photography is easy once standards are obtained. True color patterns can be obtained by printing from positive internegatives, and special techniques can be used to enhance the photographic appearance.

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SOME RELATIONSHIPS OF FOSSIL GATUN GASTROPODS TO THEIR RECENT COUNTERPARTS THROUGH THE USE OF FLUORESCENCE

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The purpose of this paper is to show relationships between some Miocene species from the Gatun Formation of Panama and their modern counterparts through the use of ultraviolet light.

This process was initially developed by the late Dr. Axel Olsson. Specimens are soaked from one to three days in sodium hypochlorite. The original color pattern can then be viewed under long-wave ultraviolet light. Photographs show much more detail than is shown by viewing the specimens directly. For photographs we use Kodak Plus-X film (A.S.A. 125) at f-11, with an exposure time of about two minutes. We use a yellow filter to remove reflected light. One must also make an internegative, as the color pattern is reversed under ultraviolet light. (All fossils from a given locality do not necessarily have the same response to ultraviolet light.)

We think that the color patterns revealed can help in understanding relationships, but the process should be used

with care. The following are some of the highlights of our work:

Turritella abrupta Spieker, 1922, has no close living relative, but appears related to *T. ocoyana* Conrad, 1855, from the Miocene of California.

Turritella altilira altilira Conrad, 1857, has close allies in both the Caribbean and Panamic provinces — the Caribbean in *T. exoleta* (Linné, 1758) and the Panamic area in *T. mariana* Dall, 1908.

Natica guppiana Toulou, 1909, appears to be similar to *N. broderipiana* Récluz, 1844, from the Panamic Province.

Cypraea henekeni Sowerby, 1850, is considered to be a forerunner of *C. mus* Linné, 1758, from the Caribbean, and the color pattern is very similar.

The Atlantic *Phos candei candei* (d'Orbigny, 1847) and the Pacific *Phos veraguensis* Hinds, 1843, appear to be living relatives of *P. candei gatunensis* Toulou, 1911.

Oliva gatunensis Toulou, 1909, is considered a possible forerunner of the Atlantic *O. reticularis* Lamarck, 1810. Considering the variability of spire shape and color patterns in this genus, it is difficult to be sure.

Cancellaria codazzi Anderson, 1929, has been considered to be closest to *C. balboae* Pilsbry, 1931, by Woodring; however, one spinose specimen shows color patterns similar to those of *C. cassidiformis* Sowerby, 1832, from the Panamic Province. In particular, a central band is present.

Conus consobrinus consobrinus Sowerby, 1850, has no modern relative and shows a distinctive color pattern.

Conus molis Brown & Pilsbry, 1911, is considered by most workers to be a forerunner of the Panamic *C. fergusoni* Sowerby, 1873, and the color pattern appears to bear this out.

Terebra cucurrupeensis Oinonikado, 1939, bears some resemblance to the modern Panamic *T. robusta* Hinds, 1844.

Pleuroliria tenagos Gardner, 1938, is considered closest to *P. picta* (Reeve, 1843) of the Panamic Province. Both the color pattern and shell morphology seem to bear this out.

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CHITONS COLLECTED BY THE AMERIPAGOS EXPEDITION TO THE GALÁPAGOS ISLANDS

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Twelve species of chitons are known to occur in the Galápagos Islands. Of these, examples of nine were collected by the Ameripagos Expedition in 1971. All except one species, which is also reported from the Hawaiian Islands, are restricted in distribution to eastern Pacific waters and are largely confined to the Panamic faunal province. Fifty per cent of the species are apparently endemic to the Galápagos.

PHYLOGENY OF THE PELECYPOD FAMILY CARDIIDAE

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The family Cardiidae is considered to comprise not less than five subfamilies. Three of these branched off in the Tertiary from two main stocks: Trachycardiinae and Fraginae from Cardiinae, and Laevicardiinae from Protocardiinae. If, as seems plausible, the genus *Septocardia*, long assigned to Carditacea, now is accepted as cardiid, it would fall in Cardiinae, which thus would occur as far back in time as the Noric Stage of the Upper Triassic. First records of the Protocardiinae were in the Upper Triassic also but slightly later, in the Rhaetic Stage. Generic taxa of that subfamily have been present in every geologic period since. Two are especially noteworthy: *Nemocardium* and *Pratulium*. They first appeared in the Lower Cretaceous and have survived to the present, an exceptionally long span for any heterodont group. The geologic record of Cardiinae is not so unbroken, and none of its taxa crossed the critical time boundary at the end of the Cretaceous. The two cardiid stocks that were present in the Upper Triassic, *Septocardia* and *Protocardia*, though having a family resemblance, are not very similar to each other. Therefore, the roots of the family probably must be looked for among the Lower Mesozoic or perhaps even the Paleozoic Carditacea. Looked at on a map, the fossil occurrences of the Cardiinae and Protocardiinae seem anomalous. However, modern geologic theories postulate in the Triassic a single continent, Pangaea, surrounded by a warm sea, the Tethys. What are now widely separated localities — Alaska, Nevada, Peru, Europe, and Burma — were then on the shoreline of this old continent. The shallow margins of this sea furnished just the conditions needed by the cardiiids, and they thrived.

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MYTILIDS FROM THE GALÁPAGOS RIFT

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In the spring of 1977 the Knorr-Lulu-Alvin geological expedition to the sea floor hot springs of the Galapagos Rift discovered dense concentrations of animals living within the hydrothermal vent areas at a depth of 2450 m. The animals collected include large white clams (Vesicomyidae), large and small mussels (Mytilidae), unusual "limpets," and giant Pogonophora. These specimens were distributed by the Smithsonian Institution to various scientists for identification. Other animals were photographed, several of which currently are unidentified as to phylum. Each of the four vent areas had a different community structure. The base of the food web for these organisms appears to be the abundant chemolithotrophic sulfur-oxidizing bacteria.

Examination of the shell morphology and anatomy of the

large and the small mussels indicates that they are conspecific. Based on comparison with museum specimens and a search of the literature, these mussels appear to be an undescribed genus and species.

A biological expedition to this area is planned in 1979.

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ON *Crepidula orbiculata* Dall

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Crepidula orbiculata Dall, 1919, an offshore west American species, is variable in form and sculpture. Typical *C. orbiculata* have a smooth, orbicular shell. A flat, coarsely ribbed form of it, described as a Pleistocene fossil, was given the name *Verticumbo charybdis* Berry, 1940; Berry found considerable variation in his new species, including large, smooth specimens. Shortly after its description, *V. charybdis* was reported from the Recent fauna, and several workers alluded to, but never fully realized the relationship between the two taxa.

In a recent review of the genus *Crepidula*, Hoagland (1977) included both *C. orbiculata* and *C. lingulata* Gould, 1846, in the synonymy of *C. dorsata* (Broderip, 1834). While the synonymy of either with the poorly known *C. dorsata* is very much open to question, *C. orbiculata* is quite distinct from *C. lingulata*.

Crepidula orbiculata has a thin, orbicular to flat shell, with a white to yellowish-green exterior and a white interior. The apex is tightly coiled, appressed to the shell, and never rostrate. The surface varies from smooth to coarsely ribbed. The septum is concave and partially detached along the left side by a shallow, relatively wide sulcus, joining the margin of the aperture with a gentle sinuation. The species appears to be restricted to moderately deep water, having been dredged from 91 to 402 m off California. It has been reported as occurring on shells of *Neptunea* and on rocks.

The shell of *Crepidula lingulata* has an apex which may be slightly twisted, but never tightly coiled, and the apex may be slightly rostrate. The shell usually has internal coloration, and when it shows external sculpture, it is different than that of *C. orbiculata*. The septum is detached along the left side by a deep, relatively narrow sulcus.

Controversy exists over the correct generic assignment of these species. Three names have been used — *Crepidula* Lamarck, 1799; *Crepipatella* Lesson, 1830; and *Verticumbo* Berry, 1940. The latter has been applied only to its type species, *V. charybdis*, and I believe it to be a synonym or subgenus of one of the other two. *Crepipatella* has long been used as a subgenus of *Crepidula*, and has often been given full generic status. The difference between the two taxa lies in their septa, which are concave and detached along the left side in *Crepipatella*. Hoagland (1977) considered the use of *Crepipatella* unwarranted without additional, anatomical evidence. I have not yet formed an opinion on this question and have provisionally followed Hoagland in synonymizing the two generic units.

BIOGEOGRAPHIC PATTERNS OF LAND SNAILS, PENNSYLVANIAN TO PRESENT

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The earliest known land snails are from the Pennsylvanian to Permian of eastern North America and western Europe and can be assigned to extant families. Three of the six land snail orders and five families are represented. An analysis of these fossils by Solem and Yochelson is in press.

Of the approximately 72 families of extant land snails, 37 appear in the fossil record during the Eocene or earlier; 27 have only a Pleistocene or Recent record; and only 8 show a post-Eocene Tertiary appearance. An analysis of the biogeographic stability of those taxa with an Eocene or earlier initial appearance in the fossil record was undertaken. The initial question asked was: Does the Recent distribution (other than dissemination by man) (a) include the geographic point of first appearance; (b) has it shifted a few hundred miles from the point of first appearance; or, (c) has it moved several thousand miles from the point of appearance? Despite their minimum 40 to 350 million year age, nearly all these families have only a one or two continent distribution. Of the 37 families, 26 (70.3%) have "sat tight," 4 (10.8%) have "shifted," and only 7 (18.9%) have "moved," exhibiting an extraordinary degree of stability through time.

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COMPARATIVE MICROANATOMY AND FUNCTION OF THE SPERMATHECA IN SELECTED PULMONATE GASTROPODS

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Functional studies of the spermatheca in four species of *Sonorella* (*S. santaritana* Pilsbry & Ferris, 1915; *S. odorata* Pilsbry & Ferris, 1919; *S. sabinoensis* Pilsbry & Ferris, 1919; and *S. huachuicana* Pilsbry, 1905) have substantiated a digestive role for this organ. Extracellular deoxyribonuclease and protease activity have been demonstrated in the spermathecal lumen, and ribonuclease activity has been shown to occur, for the most part, intracellularly in the columnar epithelial cells bordering the lumen. This latter enzyme, considered in the light of the intense acid phosphatase activity also shown by these cells, is strong evidence for intracellular digestion.

Two types of epithelial cells have been found with

conventional histological studies. Ultrastructural investigations have shown one of these cell types to possess microvilli and considerable endocytotic activity, further supporting the case for intracellular digestive action. Comparisons of the spermathecae of *Sonorella* with three species of *Ashmunella* and one of *Mesodon* have shown that this organ possesses a far greater number of the "adventitial" storage cells in *Sonorella* with correspondingly less connective tissue. Thus far, two cell types have not been demonstrated in *Ashmunella* or *Mesodon*, although ultrastructural studies are still pending.

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A PHENETIC CLASSIFICATION OF THE LAND SNAIL FAMILY POLYGYRIDAE

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A phenetic classification was constructed using an unweighted pair-group cluster analysis of a resemblance matrix based upon average taxonomic distance calculated for 23 OTUs (operational taxonomic units) based on 35 characters. The results are presented as a first approximation to a natural classification. Division into the subfamilies Polygyrinae and Triodopsinae is supported, with the addition of an isolated subfamily Ashmunellinae containing only *Ashmunella* Pilsbry & Cockerell. *Triobopsis* Pilsbry is transferred to the Triodopsinae, near *Allogona* Pilsbry. Within the Triodopsinae, *Cryptomastix* Pilsbry is raised to generic status and placed near *Vespericola* Pilsbry. *Triodopsis* (*s. lat.*) is partitioned into two genera, *Xolotrema* (containing the subgenera *Xolotrema* Rafinesque, *Neohelix* Ihering, and *Wilcoxorbis* Webb), and *Triodopsis* (containing *Triodopsis* Rafinesque and *Haraldorbis* Webb). In the Polygyrinae *Euchemotrema* Archer and *Stenotrema* Rafinesque form an isolated group clustering somewhere near the generic level and provisionally retained as subgenera in *Stenotrema*. The subgenera *Polygyra* Say, *Daedalochila* Beck, and *Erymodon* Pilsbry cluster tightly into a genus *Polygyra*, to which the relict Caribbean genus *Giffordius* Pilsbry is related. The subgenera of *Mesodon* (*Mesodon* Rafinesque, *Ragsdaleorbis* Webb, *Patera* Albers, *Inflectarius* Pilsbry, and *Appalachina* Pilsbry) cluster into a loosely defined genus. *Lobosculum* Pilsbry is removed from *Polygyra* and clusters with *Praticolella* Martens at a level perhaps best expressed by recognition of separate genera.

The subfamilial classification here proposed substantiates that established by Pilsbry in 1940; although he did not formally separate *Ashmunella*, he considered it to be isolated within the family, an opinion confirmed by the present study. The generic and subgeneric arrangement largely confirms the more recent results of G. R. Webb. The greatly increased set of characters provided in Webb's publications suggests the possibility of establishing an improved classification based on the phenetic assignment of ranks to taxa defined by cladistic analysis at the species level.

THOUGHTS ON *Monadenia* AND OTHER SNAILS OF NORTHERN CALIFORNIA

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The snail genus *Monadenia* Pilsbry, 1895, appears to be in the early stages of an adaptive radiation. Modern ground- and rockslide-dwelling species are variable, and from a similar source the exposed-crawling, partly diurnal, and semi-arboreal *Monadenia fidelis* (Gray, 1834) may have evolved. Once emancipated from life in holes in the ground, the *fidelis* group achieved large size, relatively high spire, and an extensive range which now reaches farther north than any other American helicacean.

Color and banding polymorphism in *M. fidelis* is most strongly developed in the southern part of its range — northern California and southern Oregon — particularly in coastal populations living on a mixed background of low vegetation. The greatest interpopulational variation occurs between isolated enclaves in the major river valleys of northern California.

In the Trinity River watershed, a riparian assemblage consisting of *Monadenia setosa* Talmadge, 1952, and other snails with affinities westward, interdigitates with an assemblage of inland forms that occurs on rocky hillsides and talus slopes.

Monadenia troglodytes Hanna & Smith, 1933, has a moderately large range in the region of Shasta Lake, with most collections being made on limestone terrane. Its reproductive anatomy resembles that of *M. churchi* Hanna & Smith, 1933; and the ranges of the two species overlap. The shell of *M. troglodytes* is shiny, light colored, and frequently opaque: characters correlated, in other snail groups, with exposed habitats and strong insolation.

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TAXONOMY AND DISTRIBUTION OF LITTORAL MOLLUSKS OF ISLA DE GORGONA, COLOMBIA

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Isla de Gorgona, in southwestern Colombia (3°00'N, 78°11'W), and Isla Malpelo are the only coraline islands on the Pacific coast of Colombia. Gorgona is approximately 55 km² and is connected to a small islet, Gorgonilla, by a 400 m channel.

We have been studying the taxonomy and distribution of the littoral mollusks of Isla de Gorgona. We have found 110 species — 81 gastropods and 29 pelecypods. Eleven of these species had not been previously reported on the Pacific coast

of Colombia — *Tegula cooksoni* (E.A. Smith, 1877); *T. picta* McLean, 1970; *Astraea babelis* (Fischer, 1874); *Vermicularia pellucida eburnea* (Reeve, 1842); *Modulus cerodes* (A. Adams, 1851); *M. disculus* (Philippi, 1846); *Cymatium pileare* (Linnaeus, 1758); *Quoyula monodonta* (Blainville, 1832); *Oliva splendidula* Sowerby, 1825; *Pinna rugosa* Sowerby, 1835; and *Atrina tuberculosa* (Sowerby, 1823). The most abundant species in the intertidal area were *Planaxis planicostatus* Sowerby, 1825; *Engina pulchra* (Reeve, 1846); *Cantharus ringens* (Reeve, 1846); *Tegula panamensis* (Philippi, 1849); *Columbella strombiformis* Lamarck, 1822; *Columbella major* Sowerby, 1832; and *Nerita scabricosta* Lamarck, 1822. The most abundant species in the infralittoral zone were *Muricanthus princeps* (Broderip, 1833) and *Megapitaria aurantiaca* (Sowerby, 1831). The most abundant species in the supralittoral zone were *Littorina modesta* Philippi, 1846, and *Melampus* sp.

Similarity, diversity, and dominance indices helped to demonstrate the differences between different study sites and tidal levels. The differences observed can be explained by environmental and biological factors.

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COMPARATIVE MORPHOLOGY OF RADULAR TEETH IN *Conus*: OBSERVATIONS WITH SCANNING ELECTRON MICROSCOPY

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Radular teeth of 22 Indo-Pacific species of *Conus* (Neogastropoda: Toxoglossa) were compared using scanning electron microscopy. The radular teeth of *Conus* are used to convey a potent venom and firmly hold a prey organism during feeding. All teeth observed can be placed in one of three known feeding modes based on morphological features: Piscivorous (fish eating), vermivorous (worm eating), and molluscivorous (mollusk eating). The radular teeth of piscivores are of two general types. In the first, two barbs and a posteriorly directed process with a recurved tip are found at the anterior end. In the second, two barbs are located at the anterior end, and the shaft is serrated for most of its length. An enlarged posterior region (terminal knob) is present in the first and absent in the second. Molluscivores possess radular teeth with two anterior barbs and in some species a serrated shaft or terminal knob. The radular teeth of vermivores are characterized by one or two anterior barbs and in most species a serrated region near the apex. A forward-projecting cone (basal spur) is usually located on the terminal knob. Piscivores and molluscivores lack such basal spurs. Previously undescribed features have been noted on the teeth of *C. obscurus* Sowerby, 1833, and *C. lividus* Hwass, in Bruguière, 1792.

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**THE LIFE AND TIMES
OF JAMES GRAHAM COOPER;
OR, BACK AND FORTH IN AMERICA**

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West American malacologists owe a considerable debt to James Graham Cooper. Cooper was one of the first west American malacologists, the first to make extensive collections on the northwest American coast. He became the first resident professional malacologist and published on a wide variety of molluscan subjects. He also made contributions to the fields of botany, ornithology, paleontology, mammalogy, and meteorology. He is responsible for new species of fish and reptiles. Much of his activity was conducted in his spare time while engaged in the practice of medicine.

He was born in 1830 in New York. After graduating from the College of Physicians and Surgeons in New York, he participated in the railroad surveys, exploring southern and eastern Washington. He remained in Washington beyond the end of the survey, then returned to the east coast to study the material he had collected and to prepare articles and reports on it. In 1857 he participated in one of the Wagon Road

Expeditions. In 1858 he visited the White Mountains of New England, and in 1859 eastern Florida. Cooper accompanied a detachment of soldiers to the west coast in 1860. There he became associated with the California Geological Survey as its zoologist and made extensive explorations in the Mojave Desert, coastal southern California, the Channel Islands, the San Francisco Bay Area and the northern Sierra Nevada.

Cooper occupies a unique position in American natural history. He explored the country from the everglades to Puget Sound, from the mountains of New England to the Mojave Desert. He was perhaps the first scientist to have a continent-wide experience, and his contributions to zoology, botany, and geology have significance to us today.

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**ON THE NATURE OF THE FOOD
OF *Diodora aspera* (GASTROPODA)
AND ITS COMMENSAL
Arctonoe vittata (POLYCHAETA)**

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[No abstract submitted]

CONTRIBUTED PAPERS

A PRELIMINARY ANALYSIS OF THE LAND MOLLUSKS OF BAJA CALIFORNIA SUR, MEXICO

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INTRODUCTION

The Mexican state of Baja California Sur occupies the southern half of Baja California peninsula and includes within its boundaries certain nearby islands. The state extends through more than 5 degrees of latitude, from its common border with the state of Baja California (sometimes called Baja California Norte to distinguish this political unit from the peninsula itself) at Latitude 28°N to its southernmost point at Cabo San Lucas, south of Latitude 23°N and within the tropic zone. Baja California Sur consists of two topographic regions of unequal size that are separated by a low isthmus southwest of the city of La Paz. North of this isthmus, in the region here called the Central Peninsula, a series of mountain ranges forms the backbone of the peninsula. The highest of these attains nearly 2000 m; the most extensive of them is the Sierra de la Giganta. These ranges drop steeply on the east to the Gulf of California but are bordered in the west by an extensive coastal plain. A number of islands lie along the Gulf coast of this part of the peninsula, and several others are situated along its Pacific coast. The La Paz isthmus isolates the southern Cape Region from the remainder of the peninsula; the Cape Region contains the highest peaks in the state, some of which exceed 2100 m, and includes the southernmost Gulf islands.

Baja California Sur is an arid region, and the availability of moisture is an important limiting factor in the ecology of the state's terrestrial mollusks. Rainfall occurs principally in the summer and fall months and is most abundant in the south, particularly in the high mountains of the Cape Region and, to a lesser extent, in the Sierra de la Giganta (Hastings & Turner, 1965). The vegetation of this portion of the peninsula is mostly tropical thorn scrub, some oak woodland being present at high elevations in the Cape Region. Elsewhere in the state, especially in low-lying regions of the Central Peninsula, little precipitation occurs at any season, and the vegetation is that characteristic of the Sonoran Desert (Wiggins, 1960; Shreve & Wiggins, 1964). Along the Pacific coast of the peninsula from Bahía Magdalena northwards fog provides a significant

amount of moisture that supplements the meager rainfall (Aschmann, 1959; Bostic, 1971).

Baja California is separated from the mainland of Mexico by the Gulf of California, a narrow arm of the Pacific Ocean. The Gulf acts as a barrier to the movement of terrestrial animals, and dispersal to the peninsula by the mainland organisms of low vagility has been restricted since the time of its formation. The plate tectonic theory of continental drift provides the currently accepted explanation of the origin of the Gulf of California (review in Gastil *et al.*, 1975); it is thought that Baja California was once contiguous with the mainland but that northwestward movement of the Pacific crustal plate (including Baja California and that part of California west of the San Andreas fault) relative to the North American plate has resulted in displacement of Baja California from the mainland. The Gulf of California occupies the gap created by this displacement. Magnetic anomalies in the seafloor at the mouth of the Gulf indicates that separation of the Cape Region from the mainland took place at least 4 million years ago (Larson *et al.*, 1968), and paleontological evidence shows the northern Gulf to be of at least Miocene age (Gastil *et al.*, 1975). The exact age of the Gulf and the details of its formation are not yet known, but it is evident that the fauna of Baja California has developed in some degree of isolation for at least 4 million years and possibly for a considerably greater period.

FAUNAL REVIEW

The terrestrial mollusk fauna of Baja California Sur consists of more than 60 species, representing 13 families and approximately 20 genera (Table 1). The following discussion of this fauna is based principally upon information gathered by the late A. G. Smith and upon the results of extensive field work conducted from 1970 to 1975 by W. B. Miller and myself. Extralimital distribution data are from Pilsbry (1939–1948) and Bequaert & Miller (1973) unless otherwise noted.

The Pacific coastline of the peninsula and the near-

shore islands from San Quintín, Baja California Norte, to Bahía Magdalena, Baja California Sur, are inhabited by species of *Xerarionta*, a strongly differentiated subgenus of *Micrarionta*; the range of the subgenus also includes the Palos Verdes Peninsula and southern Channel Islands of southern California (Fig. 1). These snails seal themselves to vegetation or to stones beneath low-lying shrubs, usually close to the shoreline. The present range of *Xerarionta* coincides closely with the occurrence of fog from the Pacific Ocean; condensation from fog provides sufficient moisture to permit activity by these snails even in the absence of rainfall and may be necessary to their survival (Miller, 1972). Fossil or subfossil specimens of *Xerarionta* have been collected on two Gulf of California islands and on the Gulf coast of the peninsula near La Paz, localities at which snails of this subgenus are probably now extinct. Other subgenera of *Micrarionta* inhabit Isla Guadalupe and the southern Channel Islands (*Micrarionta*, s. s.) and coastal southern California and Baja California Norte (*Plesarionta*).

Minute snails of the genus *Sterkia* are also inhabitants of the moist Pacific coastal region of the peninsula. The single record of the occurrence of *Sterkia* in Baja California Sur at Punta Abrejos marks the southern limit of the range of the genus in western North America; species of *Sterkia* occur along the coast, on offshore islands, and occasionally in inland locations from San Luis Obispo County, California, to Punta Abrejos. The genus has a disjunct distribution, and additional species are present in the Caribbean region. In western North America these snails live in debris under vegetation or among rocks (Roth, 1973; Christensen, unpublished observations).

Two genera of Helminthoglyptidae inhabit inland sites in the Central Peninsula region of Baja California Sur. The range of *Sonorelix* barely enters Baja California Sur, where a species of the subgenus *Herpeteros* has been collected near San Ignacio. Snails of this subgenus are widely distributed in Baja California Norte, and an additional species occurs in southern California. The nominate subgenus of *Sonorelix* is restricted to the desert mountains of southeastern California. The closely related genus *Greggelix* is more characteristic of the fauna of Baja California Sur and replaces *Sonorelix* practically throughout the Central Peninsula region of the state; the two genera occur in close proximity to each other near San Ignacio and at Bahía de los Angeles, Baja California Norte (Fig. 1). In Baja California both *Sonorelix* and *Greggelix* are usually found in talus accumulations, often in extremely arid locations.

Two species of *Radiocentrum* inhabit Baja California Sur. One of these is restricted to the Cape Region, and the other has been collected at two widely separated locations, one in the Central Peninsula near San Javier, the other in the Cape Region. These snails

live among rocks, either in deep talus accumulations or in shallow rockpiles in sheltered locations, where they may be found sealed to stones or to loose debris in soil. *Radiocentrum* has an unusual pattern of distribution; widely separated species occur in Baja California, on Catalina Island in the Channel Islands of southern California, and on the North American mainland in southern Arizona and New Mexico and in Chihuahua, Mexico (Fig. 1).

Almost everywhere in Baja California Sur members of the family Bulimulidae are the dominant large land snails, and more than half of all species of terrestrial mollusks known to inhabit the state are members of this group. Three genera of Bulimulidae, two of them precinctive, are present. The range of *Rabdotus* includes much of mainland Mexico and of the southern and southwestern United States, but the genus attains its greatest diversity in Baja California Sur, where about three-quarters of its species occur. Species of *Rabdotus* occur in suitable habitats nearly throughout the state, and the genus has undergone a significant adaptive radiation in the Cape Region, an area inhabited by few other large snails. Cape Region *Rabdotus* exhibit a remarkable variety of shell forms, from the globose *R. pilula* to the cylindrical and many-whorled *R. ramentosus*. There is also considerable diversity of habitat and estivation site preference; most species are rock-dwellers and seal to stones during periods of estivation, but some species inhabit the coastal lowlands where they estivate free-sealed in soil beneath vegetation or sealed to the trunks of trees in sites exposed to the sun (Christensen, 1978). Other genera of Bulimulidae, *Berendtia* and *Spartocentrum*, are restricted to the Central Peninsula region of Baja California Sur. The range of *Spartocentrum* includes certain of the Gulf islands as well as the highlands of the peninsula, but *Berendtia* has been collected only on the peninsula itself (Fig. 2). These snails, like the *Rabdotus* of this part of the peninsula, are rock-dwellers and are often found in the massive accumulations of basalt talus that are a characteristic feature of the Central Peninsula. During estivation *Berendtia* seals to stones, but *Spartocentrum* is usually free in the soil filling the interstices of the talus. These genera are derivatives of the more widely ranging *Rabdotus* (Christensen & Miller, 1975).

With the exception of *Sterkia* and representatives of the family Succineidae (unidentified members of which have been collected in scattered locations throughout Baja California), each of the genera of smaller terrestrial mollusks native to Baja California Sur exhibits one of two distinct patterns of distribution. *Gastrocopta*, *Pupoides*, *Thysanophora*, *Hawaiiia*, and *Glyphyalinia* are widely distributed in the state. Some species of *Gastrocopta* and *Pupoides* are restricted to Baja California Sur, but all of these genera and most of their Baja California species are also characteristic members of the fauna of the arid regions of the

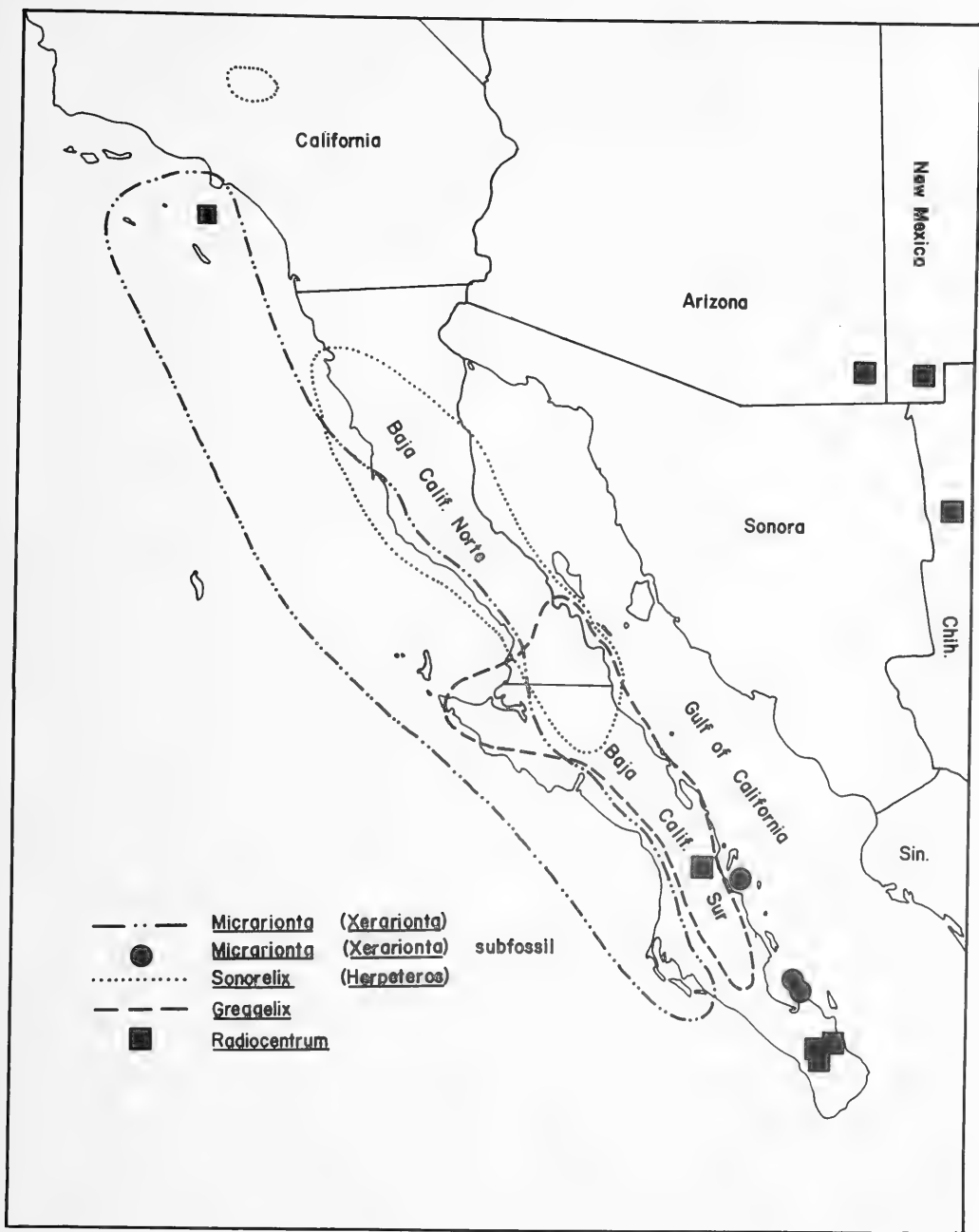


Fig. 1. Distribution of Helminthoglyptidae and Oreohelicidae in Baja California Sur, Mexico, and adjacent regions.

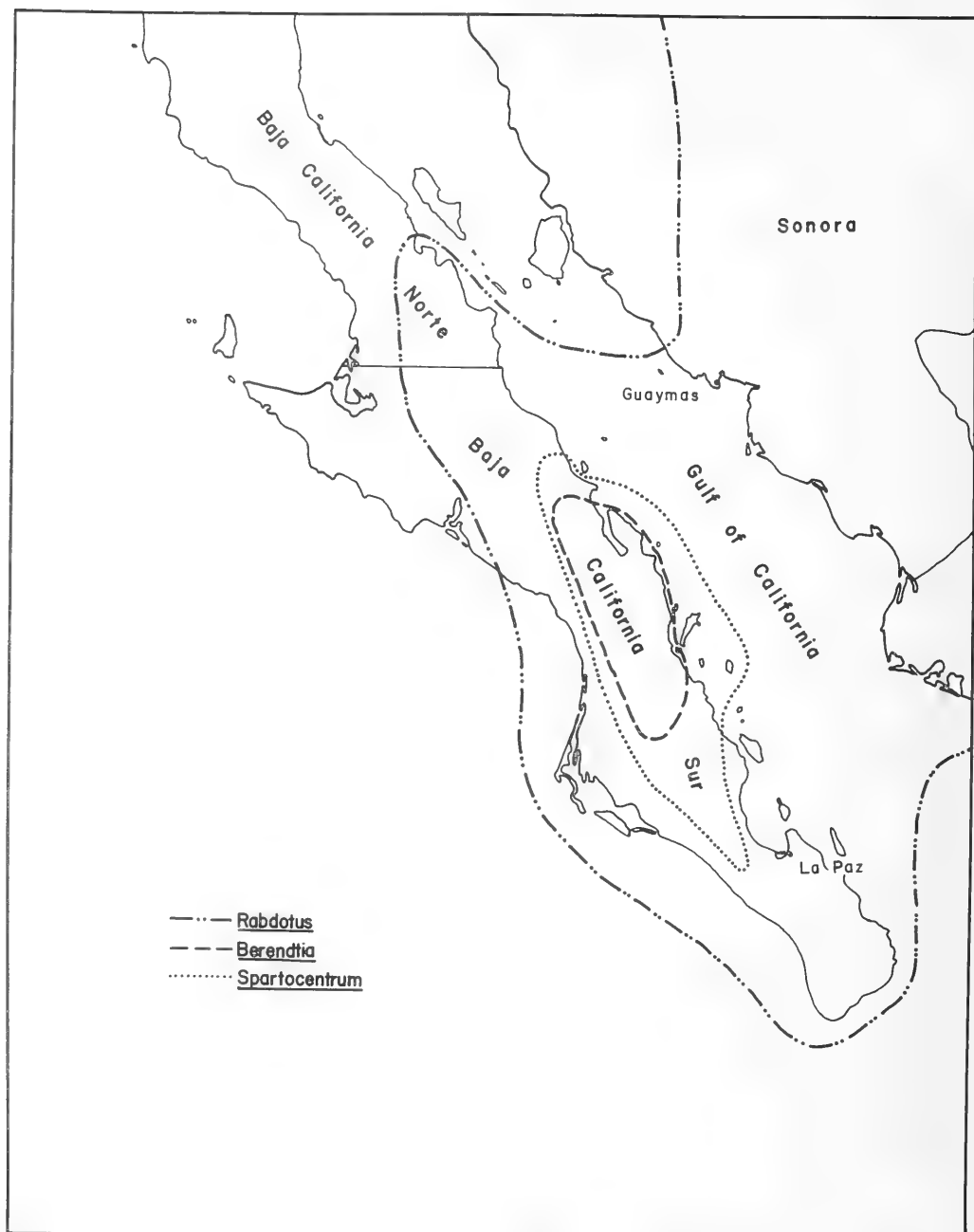


Fig. 2. Distribution of Bulimulidae in Baja California Sur, Mexico and adjacent regions.

southwestern United States and the northwestern Mexican mainland. Although a few of the species are known to occur in isolated locations in extreme southern or southeastern California, none is widely distributed in that state. The almost total absence of records of any of these genera in Baja California Norte, however, probably reflects the inadequate state of our knowledge of the minute land mollusks of that area. In Baja California Sur species of *Gastrocopta*, *Pupoides*, and *Thysanophora* are highly tolerant of arid conditions; these snails seal to stones or inhabit litter in talus and beneath vegetation, often in exposed locations at low elevations. *Hawaia* and *Glyphyalinia* occur with these in protected sites but are absent in arid, low elevation localities.

Species of *Strobilops*, *Pseudosubulina*, *Deroceras*, and *Vertigo* are apparently less tolerant of xeric conditions than are those of more widely distributed genera of small to minute mollusks, and in Baja California Sur are restricted to the Cape Region where they inhabit relatively moist locations, usually at moderate or high elevations. Endemic species of *Strobilops* and *Pseudosubulina* occur here; related forms inhabit mainland Mexico, but are restricted to the tropical thorn scrub region and do not live in the arid Sonoran Desert of northwestern Mexico and southwestern United States. The slug *Deroceras* is more widely distributed in western North America (but restricted in arid regions to higher elevations) than are such genera as *Gastrocopta* and *Pupoides*. The presence of *Vertigo ovata* in the Cape Region is unexpected, as the nearest reported occurrences of this species are in central California, southern Arizona, and extreme northern Sonora; perhaps the species will be found to occur more generally in mainland Mexico when the minute snails of that region are more thoroughly studied.

The only non-native land mollusks known to inhabit Baja California Sur are unidentified species of *Lamellaxis* or *Opeas* that have been collected at several locations in the Cape Region. A number of species of these closely related genera have spread throughout the tropics due to the influence of commerce; they are probably of tropical American origin.

ZOOGEOGRAPHIC ANALYSIS

Almost all of the native terrestrial mollusks of Baja California Sur can be identified as having affinities either with the fauna of the Californian region to the north or with that of mainland Mexico, eastward across the Gulf of California. A few widely distributed taxa and a small number of relict forms are also present. It should be noted that the Central Peninsula and Cape Region of the peninsula are distinct faunal areas. *Greggelix*, *Berendtia*, and *Spartocentrum* occur only in the former, whereas *Rabdotus* is most diverse in the Cape Region; only 2 species of large snails (1 of

Rabdotus, 1 of *Radioentrum*) occur in both areas.

Characteristic inhabitants of the moist Pacific coastal region of the state are species of *Micrarionta* (*Xerarionta*) and *Sterkia*, taxa of northern affinities. These are part of the distinctive assemblage of possibly fog-dependent land mollusks that occur principally in coastal locations and on offshore islands from southern California to Bahia Magdalena. Taxa restricted to this region but not extending into Baja California Sur include two additional subgenera of *Micrarionta*, the arionid semi-slug *Binneya*, and *Pupilla* (*Striopupilla*). *Sonorelix* and *Greggelix*, helminthoglyptid snails of arid inland habitats in Baja California Sur, are also northern elements in the fauna but have affinities with groups inhabiting the desert mountains of southern California and Baja California Norte.

The numerous bulimulid snails of Baja California Sur are related to taxa inhabiting the mainland of Mexico, although only one of the three genera and none of the species present in Baja California also occur on the mainland. The highly endemic nature of the Bulimulidae of the peninsula is indicative of their lengthy residence there; their ancestors were probably present in Baja California prior to its separation from the mainland and have evolved in isolation since that time.

Radiocentrum is the only genus of large snails with a distribution that includes Baja California Sur, the Californian region, mainland Mexico, and the adjacent southwestern United States. This pattern, in which a few localized species are scattered over a large geographical area, is indicative of a relict group.

The affinities of most of the small land mollusks of Baja California Sur are with the fauna of mainland Mexico, and a majority of the peninsular species occur on both sides of the Gulf of California. This is unlike the situation with the larger mollusks, no species of which is present both in Baja California and on the mainland. In the smaller forms the resemblance of the peninsular and mainland faunas may be due less to the former contiguity of these areas than to their ecological similarity and to trans-Gulf dispersal. The Gulf of California is probably a much less effective barrier to the dispersal of minute snails than to larger species. The presence on the Islas de Revillagigedo, an oceanic group of volcanic origin located 400 km southwest of Cabo San Lucas, of such minute snails as *Gastrocopta*, *Strobilops*, *Hawaia*, *Pseudosubulina*, and *Thysanophora* provides an indication of their vagility. Conversely, no representatives of the large Helminthoglyptidae, Oreohellicidae, or Bulimulidae occur in these islands (Dall, 1926; A. G. Smith, unpublished observations).

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Table 1.

Summary of the terrestrial mollusks of Baja California Sur.

	Precinctive Species	Other Native Species	Total Species
Vertiginidae			
<i>Sterkia</i>	0	1	1
<i>Vertigo</i>	0	1	1
Chondrinidae			
<i>Gastrocopta</i>	1-2	2	3-4
Pupillidae			
<i>Pupoides</i>	1	1	2
Strobilopsidae			
<i>Strobilops</i>	1	0	1
Succineidae (unidentified taxa)	?	?	ca. 2
Limacidae			
<i>Deroceras</i>	0	1	1
Zonitidae			
<i>Glyphyalinia</i>	0	1	1
<i>Hawaiiia</i>	0	1	1
Subulinidae			
<i>Lamellaxis</i> or <i>Opeas</i>	(introduced)		2
Spiraxidae			
<i>Pseudosubulina</i>	2	0	2
Bulimulidae			
<i>Berendtia</i>	1	0	1
<i>Rabdotus</i>	28*	0	28
<i>Spartocentrum</i>	ca. 6	0	ca. 6
Thysanophoridae			
<i>Thysanophora</i>	0	1	1
Oreohelicidae			
<i>Radiocentrum</i>	2	0	2
Helminthoglyptidae			
<i>Greggelix</i>	ca. 5	0	ca. 5
<i>Micrarionta</i> (<i>Xerarionta</i>)	1	1-2	2-3
<i>Sonorelix</i> (<i>Herpeteros</i>)	0	1	1
	ca. 48+	ca. 11+	ca. 64

*Includes one species the range of which extends a short distance into Baja California Norte

A PRELIMINARY REPORT ON THE LAND SNAILS OF THE CENTRAL GREAT BASIN

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INTRODUCTION

The Central Great Basin (Hunt, 1967) is characterized by a series of high northeast-trending faultblock ranges separated by elevated valleys, the latter generally above 1500 m. To the east the region is bounded by the formidable and long-standing biogeographic barrier of the Bonneville Basin. To the west and south the Lahontan Basin and the low, desert ranges of the Tonopah section (Cronquist, *et al.*, 1972) and of the Mohave Desert form similar barriers. To the southeast the Pine Valley and Bull Valley Mountains of Washington County, Utah, offer a potential biogeographic connection with the southern Utah Plateaus (Cronquist, *et al.*, 1972). Indeed, McMillan (1948) considered the floristic relationships of the Deep Creek Range, on the northeastern edge of the Central Great Basin, to be with the southern Utah Plateaus through the ranges of eastern Nevada and southwestern Utah. To the north the basalt flows of the Snake River Plains and Owyhee Desert (Cronquist, *et al.*, 1972) have presented a barrier to dispersal of plant and animal life since the Tertiary Period. The ranges along the northern edge of the Bonneville Basin offer a possible corridor to the Wasatch Ranges of northern Utah and southeastern Idaho.

The intermontane valleys are primarily vegetated by sagebrush communities, *Artemisia tridentata* being the usual dominant. Some of the lower valleys are occupied by shadscale (*Atriplex*) communities. The ranges are vegetated by single-needle pinyon — utah juniper (*Pinus monophylla* — *Juniperus osteosperma*) woodland at elevations between 1800 and 2300 m. Above 2300 m, the tolerance limits of pinyon and juniper are exceeded (Cronquist, *et al.*, 1972), and an upper sagebrush community, dominated by *Artemisia tridentata vaseyana*, with frequent stands of mountain mahogany (*Cercocarpus ledifolius*) and aspen (*Populus tremuloides*), is found in place of the coniferous forest that would be expected in much of the montane west. Coniferous forest dominated by white fir (*Abies concolor*), douglas fir (*Pseudotsuga menziesii*), and ponderosa pine (*Pinus ponderosa*) occupies this zone in the Deep Creek and the Snake ranges. Coniferous forest also occurs in sheltered canyons of the Schell Creek Range and in the Grant and Quinn Canyon Ranges. Local stands of white fir occur in most of the higher ranges. Above 2800 m an open subalpine forest of bristlecone pine (*Pinus longaeva*) and limber pine (*Pinus flexilis*) replaces the upper sagebrush association.

This region of approximately 125,000 km² has long been noticeable as a blank spot on molluscan distributional maps. Newcomb (1870) described *Helix hemphilli* [= *Oreohelix hemphilli*] from the White Pine Range. Gratacap (1901) reported that the collection used by Binney (1878) also contained *Pupilla* sp. (probably *P. hebes*), *Discus cronkhitei*, *Euconulus fulvus*, and *Vitrina pellucida* from the same range. Walker (1916) reported one specimen each of *Vallonia gracilicosta* and *V. cyclophorella* (I question the identification of *V. gracilicosta*) from the Cortez Hills, *Oxyloma nuttalliana* from the Cortez Hills and the Humboldt River floodplain, and *Succinea rusticana* from the Humboldt River floodplain, in Eureka County, Nevada. Berry (1932) described *Oreohelix nevadensis* from the Schell Creek Range, and Roscoe (1954) published a short list of species from the Deep Creek Range. These represent all of the published records of land snails in the region. Henderson (1931) tentatively included the region in his Rocky Mountain molluscan province because of the occurrence of *Oreohelix* and the apparent absence of *Polygyra* (then including *Cryptomastix*, *Vespericola*, and *Allogona*), *Gonio-basis* (then including *Juga*), *Haplotrema*, and *Anguispira*.

METHODS

The studies reported here were undertaken as a preliminary survey, in preparation for an intensive investigation of the zoogeography and taxonomy of land snails in the Central Great Basin. Nine easily accessible ranges distributed over the region were chosen for preliminary sampling (Fig. 1). Five sites were sampled in the Toiyabe Range, one in the Simpson Park Range, two in the Diamond Range, four in the Schell Creek Range, four in the Snake Range, five in the Quinn Canyon Range, one in the Highland Range, four in the Clover Range, and three on Pahute Mesa. Each site was examined until additional species ceased to be found, and for a minimum of one hour. Rocks, logs, and bark slabs were turned, leaf litter carefully sorted, and the soil around the roots of trees and shrubs dug through. Rock slides were excavated to a depth of about 50 cm, each rock being carefully examined for attached small snails. Special attention was paid to small forms, and litter samples were collected at each site for later sorting. Precise locality, altitude, slope, vegetation, and rock type were recorded for each site.

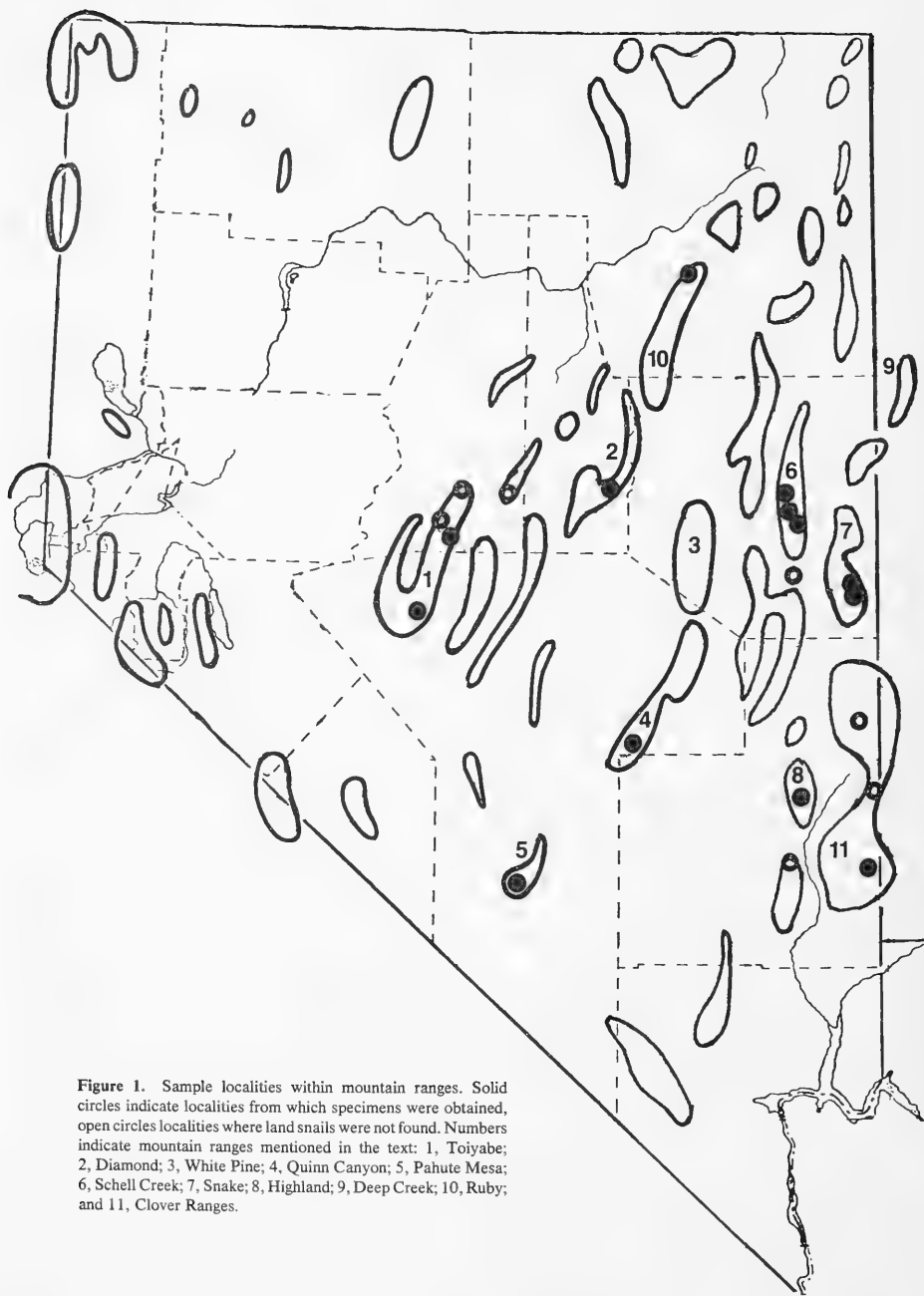


Figure 1. Sample localities within mountain ranges. Solid circles indicate localities from which specimens were obtained, open circles localities where land snails were not found. Numbers indicate mountain ranges mentioned in the text: 1, Toiyabe; 2, Diamond; 3, White Pine; 4, Quinn Canyon; 5, Pahute Mesa; 6, Schell Creek; 7, Snake; 8, Highland; 9, Deep Creek; 10, Ruby; and 11, Clover Ranges.

RESULTS

The known geographic distribution of land snails in the Central Great Basin is summarized in **Table 1**. Speculative corrections of literature records that I consider to be incorrectly identified are indicated by a query.

Four species, *Vallonia cyclophorella*, *Discus cronkhitei*, *Vitrina pellucida*, and *Euconulus fulvus*, seem to be widely distributed. *Oreohelix* species of the *O. hemphilli* group occur seemingly throughout the region, whereas members of the *O. strigosa* group have been found only in the Schell Creek, Snake, Ruby, and Deep Creek ranges. The more eastern ranges (Ruby, Schell Creek, Deep Creek, Snake, Quinn Canyon, and Clover ranges) have strikingly more diverse faunas. Thorough collecting of favorable habitats in the Toiyabe Range has yielded abundant material, but only six species, and on Pahute Mesa only two species were found, whereas much less thorough collecting in the Schell Creek Range has produced twelve species.

No snails have been found in the subalpine forest to date. In the upper sagebrush zone of the western ranges only the widely distributed *Vallonia cyclophorella*, *Discus cronkhitei*, *Euconulus fulvus*, and *Vitrina pellucida* have been found, primarily in birch thickets around seepage springs. In the Schell Creek Range an *Oreohelix* of the *O. strigosa* group was common in rockslides in Timber Creek Canyon.

The coniferous forest has a more diverse fauna; *Pupilla blandi* and *Microphysula ingersolli* have been found only here, and *Vallonia cyclophorella*, *Discus cronkhitei*, *Glyphyalinia* sp., *Hawaii* sp., *Zonitoides arboreus*, *Vitrina pellucida*, *Euconulus fulvus*, and *Oreohelix* of both species groups also occur in this habitat. In the pinyon-juniper woodland, land snails are restricted to especially favorable habitats on sheltered slopes, in rockslides, near springs, and along streams. *Cochlicopa* sp., *Pupilla hebes*, *Pupoides hordaceus*, *Vertigo gouldi*, *Deroceras* sp., and *Catinella* sp. seem to be restricted to this zone. *Deroceras* sp. and *Catinella* sp. are restricted to wet ground around springs; *Cochlicopa* sp., *Vertigo gouldi*, *Glyphyalinia* sp., *Hawaii* sp., and *Zonitoides arboreus* are found only in the most mesic habitats, in shaded rockslides, on deeply shaded slopes, and along the floor of canyons with flowing streams. *Pupilla hebes* and *Oreohelix* of both species groups are found sporadically in much drier habitats as well, in rockslides and burrowing along rock ledges. *Discus cronkhitei*, *Vitrina pellucida*, and *Euconulus fulvus* are found in streamside vegetation, which they follow well down into the lower sagebrush zone. *Vallonia cyclophorella* occurs in all habitats supporting snails, and is found occasionally on all but the driest and most exposed slopes. To date no land snails have been found in the lower sagebrush zone. Marshy areas on the valley floors have not yet been investigated in detail. Casual collecting indicates that some, at least,

support *Oxyloma* of one or more species and *Vertigo binneyana* Pilsbry.

The *Cochlicopa* reported above probably belong to an undescribed species that is widely distributed in the southwest (F. W. Grimm, in litt.). Similarly, the *Catinella vermata* complex, to which the populations reported above belong, seems to consist of several species, which are now under study (D. S. Fransen, pers. comm.). I am presently studying the remaining taxa now identified only to genus. *Deroceras* sp. has been found in two ranges of the study area and in the outlying Spring Range to the south. It belongs to the *D. laeve* group but differs from *D. laeve* (s. str.) in numerous anatomical details and in its massively thickened, proportionately wider internal shell. In shell characters it closely resembles *Craterarion pachyostrakon* Taylor (1954), of the upper Miocene Barstow formation [= *Deroceras pachyostrakon*, of Firby, 1967].

Glyphyalinia sp. is anatomically a member of the *G. indentata* group but is anatomically distinct from *G. indentata*, a species restricted to the eastern United States. It is also distinct from another undescribed member of the *G. indentata* group found in the Colorado Plateaus to the east. "*Retinella*" *indentata*, auctt., is a complex of species, many not closely related to *G. indentata* (s. str.), with shells that are extremely similar or identical to one another.

In *Hawaii*, also, several species have long been supposed to be a single, widely distributed species. However, the shells are fairly easily distinguished, once the existence of several species is recognised. I am presently revising this genus. The Great Basin species of *Hawaii* is sharply distinct from all other species in the genus so far dissected. The shell is immediately distinguished by its large size (2.7 mm diameter) and complete absence of radial rib-striations.

The genus *Oreohelix* seems to be represented by endemic species in each of the ranges investigated. Apparently, no single species of *Oreohelix* is shared by two unconnected ranges in the region. In the Schell Creek Range, an *Oreohelix* of the *O. strigosa* group from the western slope seems to be anatomically distinct from topotypic *O. nevadensis* from the eastern slope. The shells also differ strikingly, but conspicuous differences in shell morphology between allopatric populations are notoriously unreliable in this genus.

DISCUSSION

In terms of Henderson's (1931) divisions, the affinities of the Central Great Basin lie with the Rocky Mountain and Southwestern provinces. *Cochlicopa* sp. is southwestern; and the genera *Glyphyalinia* and *Hawaii* are widespread and important in the Southwestern province and represented only by scattered relicts in the Rocky Mountain province. Such species

as *Vallonia cyclophorella*, *Pupilla hebes*, *Pupoides hordaceus*, and *Microphysula ingersolli*, however, are primarily Rocky Mountain taxa that intrude into the Southwestern province (Bequaert & Miller, 1973), and the *Oreohelix hemphilli* and *O. strigosa* groups are shared only with the Rocky Mountain province. Additionally, such characteristic Southwestern genera as *Radiocentrum*, *Sonorella*, *Ashmunella*, and *Holospira* are absent. There seems to be little question that, in Henderson's (1931) terminology, the Central Great Basin is part of the Rocky Mountain molluscan province.

The history of the fauna would seem to be one of increasing fragmentation and extinction since the middle Tertiary. During the early Miocene the area of the Central Great Basin was occupied by mesophilic hardwood-deciduous forest of the Arcto-Tertiary Geoflora (Axelrod, 1950). The molluscan fauna, judging by the survivors, must have resembled that of northern Idaho today. The Mohave Desert region was occupied by xerophilic encinal woodland (see Lowe, 1964 for description of encinal), chapparal, thorn forest, and semidesert vegetation of the Madro-Tertiary Geoflora (Axelrod, 1950), and its land snail fauna, judging from that of the upper Miocene Barstow formation (Taylor, 1954), may have resembled that of present day southern California. With increasing aridity during the later Miocene the Madro-Tertiary woodlands moved northward, occupying the lowlands, and the Arcto-Tertiary flora and fauna were restricted to the developing basin ranges. During the Pliocene, uplift of the Sierra Nevada produced an increasingly severe rainshadow to the east. Semiarid woodland, similar to that found on the drier borders of modern conifer- and oak-woodland in the southwest (Axelrod, 1948), occupied the lowlands, restricting the evolving pinyon-juniper woodland to the lower slopes of the ranges. Snails of the Madro-Tertiary fauna would have been isolated in each range at this time, except for species capable of anemochoric distribution (wind dispersal). By middle Pliocene time, precipitation was reduced to little more than modern amounts, with drastic reductions in summer rainfall (Axelrod, 1944). Sagebrush communities dominated the lowlands, and the reduction in summer rainfall led to the gradual elimination of Arcto-Tertiary conifer forest over most of the Great Basin, producing the upper sagebrush zone.

During the Pleistocene a xerophilous woodland of Utah juniper (*Juniperus osteosperma*) spread downward, occupying the intermontane valleys of the Mohave Desert and southern Great Basin (Wells & Berger, 1967). Similar woodland probably occupied the lowlands in most of the Central Great Basin during glaciations. Extensive lakes formed in many of the basins at this time. *Discus cronkhitei*, *Microphysula ingersolli*, and *Oreohelix* spp. represent probably Arcto-Tertiary survivors. *Pupilla blandi*, *P. hebes*, and *Vallonia cyclophorella* also may be added to the Arcto-Tertiary list, as *P. blandi* and *V. cyclophorella*

are known from Tertiary deposits (Hibbard & Taylor, 1960). Probably remnants of the Madro-Tertiary fauna include: (1) *Deroceras* sp., closely allied to a species found in an upper Miocene deposit within the Madro-Tertiary woodlands (Taylor, 1954); (2) *Hawaiiia* sp., a member of a genus found in the same Miocene deposit and widespread in Madro-Tertiary derivatives in the modern southwest; (3) *Glyphyalinia* sp., belonging to a genus characteristic of southwestern Madro-Tertiary derivatives (although unknown as a Tertiary fossil); and (4) *Pupoides hordaceus*, characteristic of dry, Madro-Tertiary-derived habitats over most of its range. During the Pleistocene, dispersal between ranges was possible, at least for species that could follow streams and occupy the margins of lakes. It was probably at this time that *Euconulus fulvus* and *Vitrina pellucida* were added to the fauna. Both are conspecific with Eurasian snails, and neither is known from the North American fossil record prior to the middle Pleistocene, although *E. fulvus* is known from the middle Pliocene of Europe (Hibbard & Taylor, 1960). Other species that may have been dispersed during the Pleistocene include *Pupilla hebes*, *Pupoides hordaceus* (much more generally distributed during Pleistocene time than at present), *Discus cronkhitei* (associated with *Vallonia cyclophorella*, *E. fulvus*, and *V. pellucida* along streams), *Deroceras* sp., and *Hawaiiia* species. Taylor (1967) found *Vallonia cyclophorella*, *Pupilla* sp., and *Hawaiiia* "minuscule" in material from Wisconsin-stage marshes near Las Vegas, Nevada. *Hawaiiia* sp., of the species widespread in Arizona, and *Vertigo berryi* Pilsbry, one of the species reported by Taylor, have been found alive in marshes along the Muddy River, Clark County, Nevada. It seems probable that *Vallonia cyclophorella*, *Pupilla hebes*, and *Hawaiiia* sp. could have occupied similar marshes around Pleistocene lakes.

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Table 1. Geographic distribution of land snails in the Central Great Basin. An asterisk (*) indicates a range that has not been thoroughly sampled, for which the species list is believed to be seriously incomplete. Ranges are indicated by the following numbers:

1, Toiyabe; 2, Diamond; 3, White Pine; 4, Quinn Canyon; 5, Pahute Mesa; 6, Schell Creek; 7, Snake; 8, Highland; 9, Deep Creek; 10, Ruby; and 11, Clover Ranges.

RANGE	1	2	3	4	5	6	7	8	9	10	11
SPECIES											
<i>Cochlicopa</i> species						x					x
<i>Vallonia cyclophorella</i> Sterki, 1892	x	x	x	x	x	x	x	x	?	x	x
<i>Pupilla blandi</i> Morse, 1865						x	x		x	x	
<i>Pupilla hebes</i> (Ancey, 1881)	x		x		x	x					
<i>Pupoides hordaceus</i> (Gabb, 1866)											x
<i>Vertigo gouldi</i> (Binney, 1843)						x					
<i>Catinella</i> species				x							
<i>Discus cronkhitei</i> (Newcomb, 1865)	x		x	x		x	x				x
<i>Deroceras</i> species				x							x
<i>Euconulus fulvus</i> (Muller, 1774)	x		x	x		x	x				x
<i>Glyphyalinia</i> species							x		x		x
<i>Hawaiiia</i> species				x			x		x		x
<i>Zonitoides arboreus</i> (Say, 1817).						x	x		x		x
<i>Vitrina pellucida</i> (Muller, 1774)	x		x	x		x	x		x	x	x
<i>Microphysula ingersolli</i> (Bland, 1875)						x	x		x	x	x
<i>Oreohelix hemphilli</i> group	x	x	x			x	x	x	x		x
<i>Oreohelix strigosa</i> group						x	x		?	x	
TOTAL SPECIES 17+	6	*	*	7	2	12	10	*	9	5	11

RADULAR DEVELOPMENT IN THE FAMILY CAECIDAE

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Introduction

The minute members of the Caecidae are unique among the Gastropoda because of their curved cylindrical shell that is closed by a septum at the posterior end. They have a pelagic veliger, and after the larval stage they develop a spirally coiled nucleus of about two-and-a-half turns. Then the shell straightens into a curved, cylindrical tube. The nuclear whorls are smooth and polished, and, as soon as the teleoconch starts, surface sculpture appears (**Figure 1**).

As the animal grows and enlarges its shell, it constructs a septum below where it has weakened the shell's inner perimeter. This septum is cemented to the inner wall of the tube, and the glassy inner coating of the shell is extended over the septum's inner surface. The earlier part of the shell above this septum then becomes separated. **Figure 2** shows a sectioned shell after separation of its earlier stage.

The sectioned shell in **Figure 3** shows that the Caecidae construct new septa as needed by growth. The septum is apparently built from the apex downward and outward, and the larger the shell diameter the less pointed the septum is. Thus, the septum is of little use as a character in species determination. However, the septa of some species have unusual features that can assist in identification.

Moore (1962) used the external features of the animal as a major argument for placing the Caecidae in the Rissoacea. **Figures 4 and 5** show my concept of a caecid animal, and my study of various rissoaceans bears out the close relationship of the Caecidae to the other members of that superfamily.

The Caecidae, like many other rissoaceans, feed while gliding between sand grains just below the surface of the sand in the intertidal area to somewhat deeper water. They feed on diatoms and seem to grasp them with their very active tentacles, which have rigid cilia at their tips. By means of motile cilia along the inner surfaces of the tentacles the diatoms are guided to the mouth. The radula, which is in the buccal area posterior to the mouth, crushes the diatoms against the roof of the mouth or between its teeth and rakes the crushed diatom test and soft parts into the digestive tract. The useable food is digested, and the remaining detritus is passed into the intestine, where it is made into fecal

pellets (**Figure 6**). Examination of the contents of these pellets shows only crushed grains of dark material, no whole or partially intact diatom tests or other organisms.

Only shell characters have thus far been used for generic and specific taxonomic placement, probably due to the minute size of the animal and even smaller size of its radula.

The dried animals of most Caecidae are fairly transparent after being softened, and the internal parts can be seen to some degree, especially the radula, which stands out clearly in the buccal mass (**Figures 6, 7**).

Published information on the radulae of the Caecidae is limited. The radulae of two Atlantic species were described by Marcus & Marcus (1963), who gave diagrams of single teeth. The radulae are taenioglossate, with a pattern of $2 + 1 + R + 1 + 2$. This is the same pattern as in the Rissoacea and gives further support to Moore's placement of the Caecidae there. **Figures 8 and 9** are diagrams of the radular patterns of two species of different rissoacean families.

Methods

For the study of minute shells I have a binocular microscope with a range of $10\times$ to $60\times$. When dissecting, I use fairly intense diffused backlighting. For obtaining radulae from minute animals I have developed very fine probes, both straight and hooked. All work is done on glass slides to allow easy movement and observation during processing. A very fine dropper is used to apply fluids, and a fine paint brush serves many purposes.

Shells that appear to have bodies within are selected, and the shell is broken into several pieces with small nail nippers. The body is teased out of the broken shell in a drop of clean water using the probes. The pieces of broken shell are placed in a labelled micromount. A solution of NaOH is added to the body, and this is repeated several times until it is sufficiently macerated to permit removal of the radula. Observation of the body and radula is possible during this process by placing the slide under a compound microscope at $150\times$.

When maceration is completed, the radula is removed by picking it up with a probe and transferring it



Figure 1. Typical *Caecum* protoconch.



Figure 2. Sectioned caecid shells showing septa and shell walls (Traced from photographs)

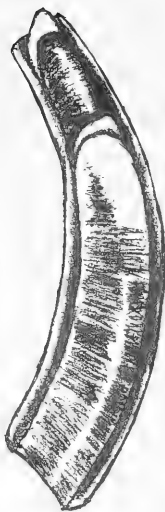


Figure 3.

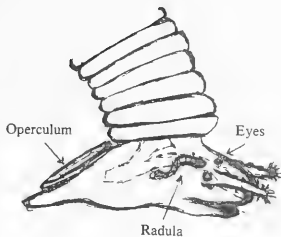


Figure 4. Side view of caecid animal



Figure 7. Radula of *Caecum* in tension within buccal mass (Traced from photograph)



Figure 6. *Caecum* body as taken from shell, after softening

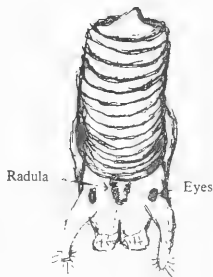


Figure 5. Dorsal view of caecid animal

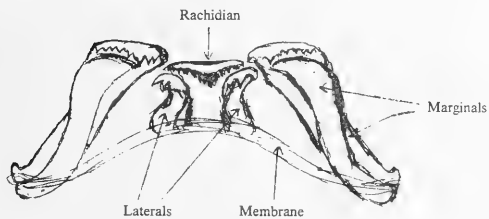


Figure 8. Diagram of probable arrangement of radular teeth in *Alvinia compacta* (Drawn from photograph through microscope at 430X)

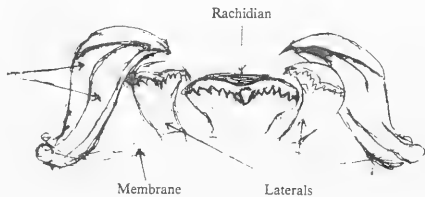


Figure 9. Diagram of probable arrangement of radular teeth in *Parviturboidea monile* (Drawn from photograph through microscope at 430X)

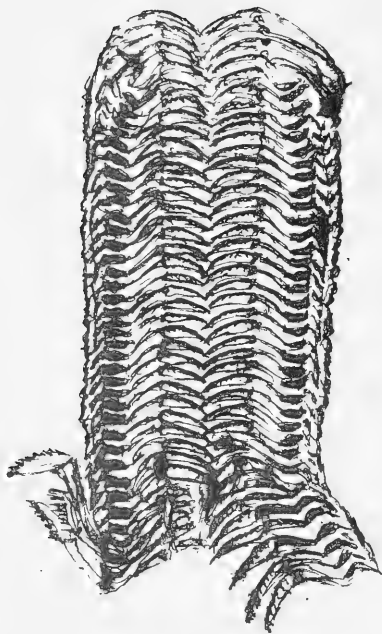


Figure 10. Active end of radula of *Caecum laqueatum* as seen through optical microscope at 430 \times . (Traced from a photograph) Actual size: 0.24mm \times 0.10mm

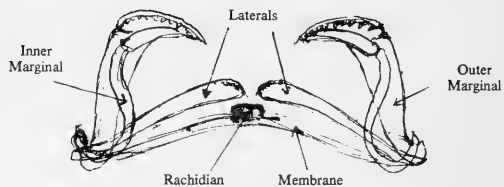


Figure 11. Diagram of probable arrangement of radular teeth in *Caecum* when in tension in buccal mass as in figure 7

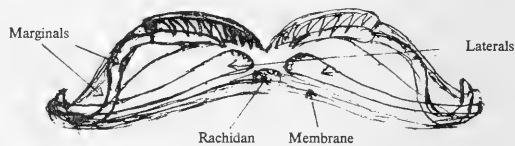


Figure 12. Diagram of probable arrangement of radular teeth of *Caecum laqueatum* shown in figure 10

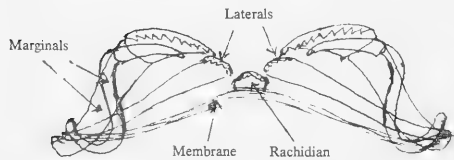


Figure 14. Diagram of probable arrangement of radular teeth of *Fartulum laeve* shown in figure 13

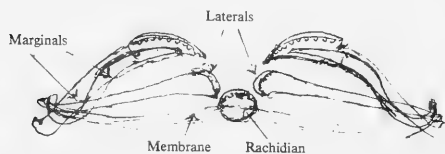


Figure 15. Diagram of probable arrangement of radular teeth of *Elephantulum insculptum*



Figure 13. Anterior two-thirds of radula of *Fartulum laeve* as seen through microscope at 430 \times (Traced from photograph) Actual size: 0.22mm \times 0.05mm

to a drop of carmine solution. Any remaining tissue takes a deeper stain than the radula and can be carefully teased off. At this stage the radula may be partially broken up for better viewing of individual teeth. However, removing individual teeth is difficult because they are imbedded in the membrane and interlocked with each other.

A small cover glass is prepared with a drop of mounting stabilizer and inverted on the radula. It is carefully pressed down to eliminate air bubbles and to arrange the radula for best viewing. To locate the minute radula (0.3 mm or less in length), I place a ring of black spots around it using dio-sol paint, which dries quickly and is insoluble in water and most cleaning fluids.

A compound microscope with lenses to obtain 150 \times and 400 \times or more is necessary for viewing these radulae. A binocular compound microscope is helpful in obtaining a stereoscopic view with increased resolving power. I use one side of such a microscope to make my photographs, usually with only the microscope's lens as my camera lens. Magnification as high as 945 \times does not provide sufficient light for more detailed viewing or for photography unless oil immersion is used, and I have not yet successfully done this.

Results and Conclusions

I obtained radulae from 30 species of Caecidae from the eastern Pacific and five from the Atlantic and Caribbean. For comparative purposes, radulae were also obtained from 17 species of other rissoacean families, including species of *Alvinia*, *Amphithalamus*, *Barleeia*, *Cyclostremiscus*, *Parviturboidea*, *Tenostoma*, and *Vitrinella*. Moore (1962) suggested that *Parviturboidea* is the most closely related genus to the Caecidae from among those rissoaceans he studied, so I picked *P. monile* (Carpenter, 1857) as one of the species I studied (Figure 9). All of these rissoaceans have basically similar radulae. They have well developed rachidian teeth, usually of a triangular shape, with a row of denticles across the front and sometimes a larger triangular central cusp. The lateral teeth are close to each side of the rachidian and usually denticulate, and they curve directly up from the membrane in which they are imbedded. The two marginal teeth on each side are usually about one third the width of the ribbon. They curve inward, with their outer ends imbedded in a fold at the outer edge of the ribbon. The marginal teeth arch inward, reaching to the laterals, the inner marginal enclosed in and supporting the outer. The outer marginals vary from smooth to finely denticulate (Figures 8, 9).

The radulae of the Caecidae are generally uniform in pattern, varying in size in proportion to the size of the animal and shell. The radular ribbon bends upward and forward (Figure 4), the anterior portion being the active, working part. In the buccal mass, the anterior

portion is held in tension, with the teeth at either side pulled laterally, leaving a clear appearing space through the middle of that part of the radula. After the buccal mass is macerated, the active radular teeth also move into a folded position.

In caecid radulae the central rachidian teeth are very weak, vestigial, or even missing. When present, they are armed with a row of very minute denticles. The rachidians are usually shaped like a half-moon, with denticles on their inner margins (Figures 11, 12, 14, 15).

The caecid lateral teeth differ from those of other rissoaceans I studied in that they are imbedded at the outer margin of the ribbon, rather than near the rachidians. They extend inward almost to the rachidians but are articulated so they can swing outward. Their inner ends are enlarged slightly and have a row of tiny, forward-pointing denticles.

In the Caecidae the marginal teeth appear to perform the major radular functions. The outer marginals are the stronger and extend inward from the outer edge of the radular ribbon. They have a slightly curved, flat shaft and a pointed, curved cusp armed with a row of denticles (Figures 10, 11). These denticles differ in shape and number among species and may be helpful in differentiating them.

The inner marginals also extend from the outer edge of the ribbon in a deep curve and end up within the outer marginal cusps, probably acting as supporting teeth. Their inner edge is weakly cusped, showing a row of fine denticles in some species.

The basic pattern of the radula of the Caecidae differs considerably from that of other rissoaceans, but appears to have evolved from a common ancestor well before the Miocene when the first fossil caecids are known.

The length of the outer marginal teeth of the caecid radula appears to be an important character in generic ranking. Figures 10 and 12 show diagrams of a radula in which the marginal teeth overlap. This type of radula was found in all caecids that have distinct raised annular rings in their shell sculpture, species long placed in the genus *Caecum*.

Micranellum was established for shells having flat, closely spaced annular rings. The radulae of these species also prove to have marginals reaching the center line of the ribbon. Thus, it seems that placement of *Micranellum* as a subgenus of *Caecum* is appropriate.

Species with longitudinal ribs as well as rings have been placed in *Elephantanellum*, which has been ranked as a genus or subgenus. Three such species in which radulae were examined also have marginal teeth extending to the center line. This supports ranking *Elephantanellum* as a subgenus of *Caecum*.

Caecids with a smooth shell or with only low

annular ripples on part of their shell have been placed in *Fartulum*, which was first made a section of *Caecum*. Later it was made a separate genus and recently again made a subgenus by Abbott (1974). The radulae of such species prove to differ from those of the ringed species in two respects. First, the marginal teeth do not extend to the centerline, but reach only to the rachidians. Second, the rachidian teeth are stronger, being arched, with tiny denticles along their inner edge (Figures 13–15). I believe that these radular differences, along with the shell differences, are sufficient reason to regard *Fartulum* as a genus.

Two species of the Caecidae that have been assigned to the subgenus *Elephantulum* because of their longitudinal sculpture and lack of rings have radulae of the same type as *Fartulum*. This confirms placement of *Elephantulum* as a subgenus, but of *Fartulum* rather than of *Caecum*. One other species, *Caecum mirificum* de Folin, 1867, has longitudinal raised threads and annular ripples. Examination of radulae from this species shows that it belongs in the subgenus *Elephantulum*.

The genus *Meioceras* contains species with smooth shells that differ from those of *Fartulum* in making a half twist in their early growth stages, with tumid mature shells which are swollen in the middle and contracted at the aperture. Abbott (1974) placed *Meioceras* as a subgenus of *Caecum*. The radula of *M. nitidum* Stimpson, 1851, seems to be close to the pattern of *Caecum*, but further study is needed before a decision can be made as to whether *Meioceras* should be regarded as a separate genus or a subgenus of *Caecum*.

The only other genus of the Caecidae still recognized is *Strebloceras*, which has smooth shells that do not shed their nucleus and therefore have probably not developed septa. They appear to be the most primitive of the family and probably should be retained as a separate genus. I have not yet obtained a shell with a body to permit extraction of its radula.

Acknowledgments

I wish to express my gratitude to James H. McLean for allowing me to study the collection of the Los Angeles County Museum of Natural History and to obtain many of the specimens used to extract radulae; the radulae I have obtained will later be placed in the museum collection for future use. I also wish to thank Drs. McLean and Donald R. Moore for help in obtaining needed literature. I especially wish to thank JoCarol Ramsaran for use of her binocular compound microscope, without which this study would never have been completed.

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OBSERVATIONS ON THE LARVAL DEVELOPMENT AND BEHAVIOR OF *Chrysallida cincta* CARPENTER, 1864 (GASTROPODA: PYRAMIDELLIDAE)

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INTRODUCTION

In a previous paper (LaFollette, 1977), I reported that samples of the ectoparasitic gastropod *Chrysallida cincta* Carpenter, 1864, from a single host tended to be phenotypically homogeneous, whereas larger samples (from multiple hosts) showed considerable variation. I hypothesized that the homogeneity of samples from single hosts was the result of intensive inbreeding over several generations. As prerequisite conditions for such inbreeding I suggested that the species must: (1) have a life-span considerably shorter than that of the host; (2) spend its entire life cycle, including reproduction, on the host; and (3) reproduce by means of non-swimming larvae. The supporting evidence then presented was chiefly circumstantial or speculative. Further observation now confirms each of these points, thereby strengthening the hypothesis of inbreeding.

In the same paper, I suggested that dispersal of *Chrysallida cincta* to new hosts resulted principally from the adult parasites relocating upon the death of their host and mentioned having observed this for the host *Tegula eiseni* Jordan, 1936. Evidence now suggests that accidental mechanical dislodgment may contribute significantly to dispersal, and that the new hosts may be species other than the host of origin.

ACKNOWLEDGMENTS

Most of the observations here reported were made at the Catalina Marine Science Center (CMSC) of the University of Southern California at Fisherman Cove, Catalina Island, on 1 August and 3–14 October 1977. I thank Dr. Robert Given, CMSC Director, for use of the facilities. Joy Pruit, volunteer in the Malacology Section of the Los Angeles County Museum of Natural History (LACM), provided the use of her house in Avalon for my stay. The CMSC staff and fellow visiting researchers rendered assistance in numerous ways. The paper was critically read by Hans Bertsch, Eugene V. Coan, Richard S. Houbbrick, James H. McLean, and Barry Roth. To each I am grateful.

MATERIALS & METHODS

Large numbers of *Chrysallida cincta* eggs and a few adults found on a variety of hosts provided the chance to observe larval development and spawning. A

large *Astraea undosa* (Wood, 1828) was chosen as the primary object of study because it was easy to handle and had two adult parasites and numerous egg masses containing well over 1000 eggs in various stages of development on its base. Although several *Haliotis* (*H. corrugata* Wood, 1828, and *H. fulgens* Philippi, 1845) were also studied, they proved too difficult to handle to permit regular observation. During hourly observations under a dissecting microscope, the *Astraea* was placed inverted in a small aquarium filled with fresh sea water to a depth sufficient to cover the base of the shell. The rest of the time it was kept in a large running sea water holding tank that remained at ambient ocean temperature of 20°C. Some observations were also made in the holding tank with the aid of a tripod-mounted dissection microscope. Most of the observations were of living material, predominantly at CMSC, but also at the LACM during the final stages of the study. Preserved material in the LACM collection also was examined.

LIFE SPAN AND SPAWNING SEASON

On 1 August 1977, I observed specimens of *Chrysallida cincta* on *Haliotis corrugata* in one of the running sea water aquaria at CMSC. It had been collected the previous January at a depth of 22 m at Bird Rock, Catalina Island. There were approximately 22 adult parasites on the shell at that time, of which I removed and preserved 8 (LACM 21057; see LaFollette, 1977: fig. 3). When I returned to the CMSC lab on 3 October there was only one adult *C. cincta* remaining on the host, but there were numerous egg masses and several juveniles, all 1 mm or less in height, near the margins and perforations of the shell where the adults had previously been. Numerous additional specimens of known host species, *Haliotis corrugata*, *Astraea undosa*, *Norrisia norrisi* (Sowerby, 1838), and *Tegula eiseni* were examined, but very few adult parasites were found. Egg masses were common on both *A. undosa* and *H. corrugata*, however. A few immature specimens were also found, the largest individual, on *N. norrisi* from near CMSC at a depth of 8 m, was 1.09 mm long.

The presence of a relatively large number of adults and the apparent absence of eggs or young on 1 August, followed by the virtual absence of adults but the presence of large numbers of egg masses and some

juveniles in early October suggests that the spawning period occurs principally between early August and early October and that adults die soon after depositing their eggs. A predominance of juveniles among museum specimens of *Chrysallida cincta* collected between September and January from numerous localities in southern California and western Baja California Norte supports these suggestions, but a few juvenile *C. cincta* among material collected between February and August indicates that some reproduction occurs at other times of the year.

Two species of pyramidellids, *Menestho impressa* (Say, 1821) and *Menestho diaphana* (Jeffreys, 1848), have previously been shown to have a life span of one year (Wells, 1959; Kristensen, 1970). If spawning in *Chrysallida cincta* is annual, which seems likely, then the life span also can be assumed to be one year. As the hosts of *C. cincta* are known or thought to live for several years, the occurrence of several successive generations of the parasite on a single host is probable.

EGGS, EGG MASSES, AND SPAWNING

An adult *Chrysallida cincta* was observed spawning on 6 October at 3 PM. It deposited 25 eggs in an irregularly shaped mass 2 mm in diameter in about 20 minutes. Other egg masses contained from 19 to 40 or more eggs, with 25 to 35 eggs per mass being typical. All egg masses were irregular in shape, some heaped up, others more spread out, and generally 2 to 3 mm in greatest dimension. Most of the masses were deposited in large groups, frequently overlapping, and impossible to distinguish separately. Isolated egg masses and eggs looked much like those of *Brachystomia rissoides* (Hanley, 1844), figured by Thorson (1946: fig. 120 A-C).

The eggs are oval and vary in length from 300 to 340 μ , with an average length of 320 μ . The average diameter is 270 μ . Each egg is contained in an oval "egg cocoon" a little more elongate than the egg, 390 to 410 μ long and about 300 μ in diameter. The eggs are connected to one another like beads on a string by a fine filament, the chalaza. The chalaza frequently is coiled like a loose spring. Egg cocoons are embedded in an extremely sticky gelatinous material that soon collects a covering of detritus on its surface. The stickiness of the jelly makes it difficult to remove eggs or, once removed, to detach them from the forceps.

DEVELOPMENT

The first cleavage of the eggs occurred 19 hours after spawning, the second after 22½ hours, and the third (8 cells) after 24½ hours. At 27 hours the fourth cleavage had occurred in some eggs, and by 30 hours all had reached the 16 cell stage and most were beyond it, the number of cells not countable. The *Astraea* host, with eggs attached, was transferred to a closed system aquarium (20°C) at the LACM on 14 October 1977 (the 9th day).

About half of the larvae had reached the veliger stage by the 10th day. Larval shells, though rather small, were well formed and the larvae rotated in the egg capsules at a rate of about one revolution per 12 seconds. The velum was rather small.

By the 18th day the larval shell virtually filled the egg capsule, and there was no noticeable movement. The egg membrane was still present but very faint. The jelly remained very sticky.

By the 22nd day egg membranes were gone. Larvae were quite active, twisting the shell and moving the foot. All were still imbedded in the jelly, which had lost much of its stickiness. The larval foot had narrowed considerably and there was no trace of a velum, although a tuft of cilia was visible at the anterior end of the foot.

By the 27th day all but a few of the larvae had emerged from the jelly mass. I estimated that the first young emerged on the 25th day. The jelly had become watery and had lost all of its stickiness. The emerged young were distributed over the base of the *Astraea*, some crawling but most resting between periostacal lamellae. When disturbed, the young were very active and moved so surprisingly fast that close examination under the microscope was difficult. Movement appeared to be due to ciliary action, the snails literally gliding over the surface. There appeared to be no tendency to swim. I was unable to follow the development of these young beyond this point.

Newly emerged snails quickly disappeared from the shell of the host upon which they had emerged. Their small size (320–330 μ) and the large size of the hosts made exact counts impossible, but it appears that the number may have dropped by as much as 50% in a 24-hour period. I could not determine the cause of this. Glass plates were placed on the bottom of the aquaria and carefully examined after a day to see if the young accidentally dropped off the host or deliberately left in search of new hosts. No young snails were found on the plates. A search for potential predators also proved unsuccessful, although small predators might have been overlooked as the holding tanks were large and connected to an open sea water system.

GROWTH

Although no direct observations on growth were made, indirect evidence suggests that the first two post-nuclear whorls are added and a length of 0.8 to 1.0 mm is attained within 6 weeks and more likely within a month of emergence. As mentioned above, a specimen of *Haliotis corrugata* had numerous adult *Chrysallida cincta* on its shell, but apparently no eggs or young, on 1 August 1977. The same host, observed 65 days later, had a number of young on its shell, the largest having about 2 postnuclear whorls and a length of 0.8 to 1.0 mm. As the larvae have been shown to take 25 to 27 days to emerge, a maximum of 40 days is left, and

probably somewhat less, for the observed growth to have taken place.

COMPARISONS

Non-pelagic larval development in the Pyramidellidae has previously been hypothesized for a number of species (Thorson, 1946; Robertson & Orr, 1961; LaFollette, 1977), but described only for *Brachystomia rissoides* (Hanley, 1844) (Pelseneer, 1914; Thorson 1946; Rasmussen, 1944, 1951). (The following account is a synthesis of the findings of these last three authors). The European *B. rissoides* is unusual in that it exhibits both pelagic and non-pelagic development, depending on the salinity — pelagic in marine waters and non-pelagic in brackish water. In the pelagic larval mode, the number of eggs per mass is large (230–500), the eggs small (180–200 μ), and larval development relatively rapid, with young hatching as typical swimming veligers after 6½ days.

The non-pelagic mode of development of *Brachystomia rissoides* is similar to that of *Chrysallida cincta*. The eggs are large (380–500 μ) (300–340 for *C. cincta*), and the development slow (21–25 days) (25–27 days for *C. cincta*). *Brachystomia rissoides* reaches the veliger stage after seven days (10 days for *C. cincta*), and at 20 days the larvae fill the eggs completely (18 days in *C. cincta*).

Comparison of egg masses, eggs, and newly hatched young of *Chrysallida cincta* with published figures of the spawn, eggs, and young of *Brachystomia rissoides* shows them to be essentially identical. The only difference of note (other than that *C. cincta* is apparently strictly marine) is that the young of *C. cincta* remain for several days in the jelly of the egg mass after hatching from the eggs, whereas *Brachystomia rissoides* young have not been described as doing so.

OTHER OBSERVATIONS

HOSTS

In 1977, I listed 5 known hosts for *Chrysallida cincta* — *Tegula eiseni*, *Norrisia norrisi*, *Astraea undosa*, *Astraea gibberosa* (Dillwyn, 1817), and *Haliotis corrugata*. Another species, *Haliotis fulgens* (Philippi, 1845), is here added to the list. One adult *C. cincta* and several egg masses were observed on the shell of a *H. fulgens* collected near Isthmus Cove, Catalina Island, shortly before my arrival at CMSC. The advanced state of development of the eggs indicated that they had been spawned before the host was collected.

FEEDING

Feeding or attempted feeding of *Chrysallida cincta* on *Astraea undosa* was observed on two occasions while the host was resting undisturbed on the side of the large plexiglass holding tank. On the first occasion, one

of the two parasites on the study animal crawled from its normal resting position on the base 1.5 cm back from the lip, onto the lower margin of the host's aperture and perched there rather precariously, almost entering the aperture. It extended its head and proboscis inwards along the shell and remained in this position for about 10 minutes, then returned to its original resting position adjacent to the group of eggs it had previously spawned.

A day later the same individual moved into this feeding position again, but was dislodged by a sudden jerk of the *Astraea*, perhaps in response to contact by the proboscis. Although the *Chrysallida* managed to cling to the foot of the host and after several minutes regained its position on the shell, the accident is illustrative of what is probably a common hazard. I have previously observed that the death of the host will cause the parasite to relocate on a new host (LaFollette, 1977), and I suggested that this may be an important mechanism for dispersal. Accidental dislodgment from the host may also contribute significantly to dispersal and colonization of new hosts.

BEHAVIOR

Three small-scale experiments were conducted with the limited number of parasites available. The objective was to make qualitative observations on the behavior of *Chrysallida cincta* when dislodged from their hosts to see whether dislodgment might be a mechanism for dispersal. The results, briefly, were as follows:

- (1) One adult *C. cincta* was removed from a *Haliotis corrugata* and placed in an aquarium (approximately 1.0 m \times 1.3 m \times 30 cm deep) with the host animal plus a second specimen of *Haliotis corrugata*. After 24 hours of crawling around the tank, the parasite rested on the bottom about 1 cm from the mantle of the second *H. corrugata*. During the following night the *C. cincta* crawled onto the *Haliotis* shell and in the morning was positioned near one of the open holes, a frequent location for the parasite.
- (2) Four *Chrysallida cincta*, 3 from *Haliotis corrugata*, and 1 from *H. fulgens*, were placed in the same aquarium used in experiment 1 with one *Astraea undosa*. After 48 hours, 2 of the parasites, one from each host, were on the base of the *Astraea*. The third was on the side of the tank, and the fourth could not be found.
- (3) One adult and two juvenile *C. cincta* from *Haliotis corrugata* were placed in a small (15 cm \times 22 cm \times 18 cm deep) aquarium with one *Tegula eiseni* and one *Haliotis cracherodii* Leach, 1814. After 2 hours, one of the juveniles had crawled onto the shell of the *Tegula*, the other two parasites were on the side of the tank. Seventeen hours later both juveniles were on the shell of the *H. cracherodii*, and the adult was on the bottom of the tank. After an additional 24 hours, the

adult and one juvenile were on the side of the aquarium, and the second juvenile could not be found.

These results suggest that *Chrysallida cincta*, when dislodged from its host, will actively seek out and relocate on a suitable host, either of the same species from which it was dislodged or a different species with suitable characteristics. The shell sculpture of known hosts suggests that either a highly textured surface or other shell characters offering secure hiding places are required. *Astraea undosa*, *A. gibberosa*, and *Haliotis corrugata* have roughly sculptured shell surfaces. *Chrysallida cincta* has been found only on the operculum or in the umbilicus of *Tegula eiseni* and *Norrisia norrisi*. The sculpture of *Haliotis fulgens* is only moderately rough, and that species is infrequently parasitized. Although *C. cincta* explored the *Haliotis cracherodii* in the third experiment, they did not remain, evidently failing to find a suitable resting place on its smooth surface. The juvenile parasite that explored the *Tegula eiseni* in the same experiment may have failed to find the operculum or umbilicus.

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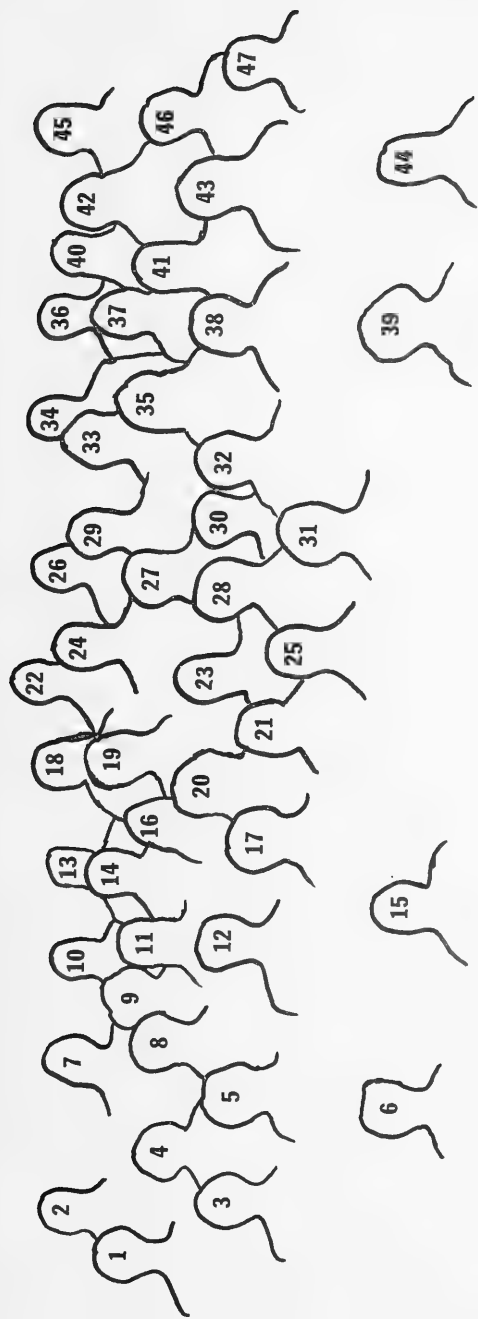
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THE WESTERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT



Corpus Christi, Texas

5-11 August 1979

Volume 12

The Western Society of Malacologists

Annual Report

Volume 12

Corpus Christi, Texas

5-11 August 1979

Joint meeting with

The American Malacological Union

Issued: MAR 24 1980

Editorial Board, 1979-1980

Dr. Hans Bertsch, Editor
Dr. Eugene Coan
Mr. Michael G. Kellogg
Dr. Barry Roth
Mrs. Raymond (Kay) Webb, Treasurer

The **Annual Report** of the Western Society of Malacologists is based on its yearly meeting. Distribution of the **Annual Report** is free to regular and student members who are, at the time of issue, in good standing. Membership dues are \$7.50 and \$3.00 for students. Others of a regular member's family may join for an additional \$1.00; each family receives only one **Annual Report**.

The Western Society of Malacologists has issued two **Occasional Papers**—No. 1, “ ‘Sea Shells of Tropical West America’: Additions and Corrections to 1975” by Myra Keen & Eugene Coan; and No. 2, “A Catalogue of Collations of Works of Malacological Importance” by George E. Radwin & Eugene Coan. Each was priced at \$2.50. The first is now out of print; the second is still available.

Correspondence regarding membership and orders for additional or back issues of the **Annual Report** or the **Occasional Papers** should be addressed to the current W.S.M. Treasurer, Mrs. Raymond D. (Kay) Webb, 501 Anita St., #186, Chula Vista, Calif. 92011.

When full-length papers are included in the **Annual Report** or **Occasional Papers** they are reviewed by two members of the Editorial Board in addition to the Editor.

NOTICE OF THE 13th ANNUAL MEETING OF THE WESTERN SOCIETY OF MALACOLOGISTS

The 1980 meeting of the Western Society of Malacologists will be held at Davis, CA, June 22-25, in affiliation with the American Association for the Advancement of Science, Pacific Division (AAAS-PD). The WSM program will include a shell and book auction, exhibits, workshops, symposia, and contributed papers. Registrants at the meeting will also have the opportunity to participate in activities sponsored by other societies meeting with AAAS-PD. The preliminary announcement and call for papers will be sent by AAAS-PD in January, 1980. Advance registration is strongly encouraged.

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MINUTES, EXECUTIVE BOARD WESTERN SOCIETY OF MALACOLOGISTS

La Quinta Royale Motor Inn
Corpus Christi, Texas
8 August 1979

The meeting was called to order by President Dr. Barry Roth; Board members present were Dr. James Nybakken, Mrs. Helen DuShane, Mrs. Carol Skoglund, Mr. William Pitt and Mr. Michael Kellogg. Dr. Hans Bertsch, Editor, also attended.

Minutes of the Board meeting of 1978 were read and approved as read.

Treasurer Mrs. Carol Skoglund reported a deficit of \$278.55 as of July 31, 1979. A motion to accept the report was made by Dr. James Nybakken, seconded by Mrs. Helen DuShane. The motion carried.

Mrs. Helen DuShane read the report of the Nominating Committee which presented the following slate of officers:

President	Dr. Vida C. Kenk
1st Vice President	Mrs. Carol C. Skoglund
2nd Vice President	Dr. Donald R. Shasky
Treasurer	Mrs. Kay Webb
Secretary	Mr. William D. Pitt
Member-at-Large	Dr. Louie N. Marinovich
Member-at-Large	Mr. David K. Mulliner

The report of the Student Award Committee was read by Dr. James Nybakken as follows:

Award of \$500.00 to Ms. Esther Leise of the University of Washington, Department of Zoology, for her project, the Polyplacophoran girdle, its structure and function.

We had the pleasure to handle the selection of a student for a \$500.00 award offered by the Southwestern Malacological Society. The student selected was Ms. Elizabeth Nesbitt from the University of California, Berkeley, Department of Paleontology, for the study of the Paleocology of the Mega-invertebrate fauna of the Cowlitz Formation of Washington and Oregon.

There was a motion by Dr. James Nybakken that we relocate our old records and annual report to the Los Angeles County Museum for storage under the care of Dr. James McLean. It was seconded by Mr. William Pitt. The motion carried.

The board instructed the Secretary to send reminder letters to delinquent members.

The option of meeting with the American Association for the Advancement of Science, Pacific Division, at the University of California at Davis, June 22-26, 1980 was discussed. It was agreed to present this recommendation to the Annual Business Meeting.

It was the consensus of the board that Mrs. Carol Skoglund investigate the possibility of having our 1981 meeting at the University of California at Santa Barbara.

The board accepted the appointment of Dr. Hans Bertsch to replace Dr. Eugene Coan as Editor.

Mrs. Carol Skoglund moved that we authorize the Editor to print 350 copies of the annual report at an approximate cost of \$1500.00. It was seconded by Dr. James Nybakken. The motion carried.

MINUTES, ANNUAL BUSINESS MEETING WESTERN SOCIETY OF MALACOLOGISTS

**La Quinta Royale Motor Inn
Corpus Christi, Texas
9 August 1979**

The meeting was called to order by President Dr. Barry Roth.

The Minutes of the 1978 Executive Board and General meeting were approved as printed in the Annual Report.

Treasurer Mrs. Carol Skoglund reported a deficit of \$278.55 for the year.

Mrs. Twila Bratcher reported on the need for an auction in the future. This opinion was concurred in by the general membership.

The report of the Student Award Committee was read by President Dr. Barry Roth.

Dr. Barry Roth read the report of the Nominating Committee, presenting the slate of officers.

There were no nominations from the floor and the slate of officers was elected by a unanimous vote.

President Dr. Barry Roth reported on the details of the AAAS Pacific Division convention at the University of California at Davis, June 22-26, 1980. Dr. James Nybakken moved that we accept the recommendation of the Executive Board that we meet with the AAAS-PD in 1980. It was seconded by Mr. Michael Kellogg. The motion carried.

Dr. James McLean reported on the AMU Conservation Committee recommendations, especially the part on the Tanner Bank (McLean resolution). There was a motion by Dr. William Emerson to endorse the concept of the McLean resolution and that the president appoint a committee to study this in more depth. It was seconded by Dr. James Nybakken. The motion carried. President Dr. Barry Roth appointed Dr. James McLean to chair the Committee, who in turn appointed his committee consisting of Dr. William Emerson and Dr. Hans Bertsch.

It was discussed whether or not we could operate with only an auction for extra income. It was concluded that we could.

It was suggested that we encourage the participation of shell clubs and have a shell night at our conventions.

TREASURER'S REPORT

August 1, 1978 to July 31, 1979

Cash on hand July 31, 1978	\$2508.94	
Paid accounts receivable from 1978	<u>43.05</u>	\$2551.99

RECEIPTS

Dues:	1974	1 regular	\$ 5.00
	1976	1 regular	5.00
	1977	3 regular	15.00
	1978	45 regular	337.50
		3 family	3.00
		2 student	6.00
	1979	172 regular	1290.00
		21 family	21.00
		12 student	36.00
			<u>\$1718.50</u>

Publications:

Annual Reports		
15 @ \$5.00	75.00	
6 @ \$7.50	45.00	
Occasional Paper #2		
5 @ \$2.50	12.50	
Reprints	<u>15.00</u>	147.50

Donations:

Student grant		10.00
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Savings account interest	<u>115.86</u>	\$1991.86
		\$4543.85

EXPENSES

Annual Report Vol. 11		
Typesetting	\$450.00	
Printing	897.79	
Postage	109.22	
Editor postage, phone	<u>34.56</u>	
		\$1491.57

Postage, supplies, printing

Secretary	274.39	
Treasurer	<u>55.85</u>	

Dues, AMU 1979	<u>330.24</u>	10.00
----------------	---------------	-------

	<u>\$1831.81</u>	
		\$2712.04

July 31, 1979

Valley National Bank, Phoenix, Arizona		
Savings Account #3690-7755	\$2538.21	
Checking Account #104-7193	<u>173.83</u>	

\$2712.04

WSM ASSETS AS OF JULY 31, 1979

Cash on hand	\$2712.04	
Accounts receivable		
Publications	20.00	
Reprints	25.00	
Treasurer's postage	<u>16.40</u>	
		\$2773.44

UNPAID OBLIGATIONS

Student grant	<u>500.00</u>
	\$2273.44

Net deficit for year \$278.55 plus any outstanding bills not submitted.

PUBLICATIONS INVENTORY July 31, 1979

1968 Vol 1	THE ECHO	90 copies
1969 Vol 2	" "	44
1970 Vol 3	" "	36
1971 Vol 4	" "	1
1972 Vol 5	" "	36
1973 Vol 6	" "	56
1974 Vol 7	ANNUAL REPORT	32
1975 Vol 8	" "	76
1975	AMU BULLETIN	83
1976 Vol 9	ANNUAL REPORT	91
1977 Vol 10	" "	127
1978 Vol 11	" "	79
1976 OCCASIONAL PAPER #2		198

ANNUAL REPORT VOLUME 11

Typesetting & printing 370 copies		\$1322.79
Cost per copy	\$3.57	
Mailing per copy	<u>.48</u>	
	\$4.05	

ABSTRACTS OF PAPERS PRESENTED TO THE ANNUAL MEETING

SYMPOSIUM: LIFE HISTORIES OF MOLLUSKS

ORGANIZERS

David R. Lindberg
Applied Sciences
University of California
Santa Cruz, CA

and

Michael G. Kellogg
Moss Landing Marine Laboratories
Moss Landing, CA

THE POPULATION DYNAMICS OF THE BIVALVES *Solen rosaceus* AND *Tagelus californianus* IN A NATURAL AND THERMALLY ALTERED ENVIRONMENT IN SOUTH SAN DIEGO BAY

Jose-Maria Merino
TOSCO Corporation
Box 814
Vernal, Utah 84078

The population characteristics of the burrowing bivalves *Solen rosaceus* and *Tagelus californianus* were observed over a 2-3 year period in south San Diego Bay in an area receiving heated effluent from a 722 MW electric generating power plant. Data collected from experimental and control areas in the bay included density, rates of growth and mortality, size-frequency distributions, reproduction, and distribution. Tolerances to high effluent temperatures were tested in the laboratory. Study results indicated that the two species had different population characteristics. *Solen rosaceus* populations had higher growth and mortality rates, and showed less tolerance to high effluent temperatures than *Tagelus californianus* populations. Reproductive and recruitment characteristics also differed between species populations. These differences are discussed with respect to influence from heated effluent and with respect to other biological factors influencing population dynamics.

MICRO-ACOUSTIC AND MICROSCOPIC OBSERVATIONS ON THE UTILITY OF MARINE GRAZING MOLLUSCS INTRODUCED TO GROW ON SUBMERGED STRUCTURES FOR THE BIOLOGICAL CONTROL OF MARINE FOULING

Christopher L. Kitting
University of California at Santa Barbara
Marine Science Institute and University of Texas
Port Aransas Marine Laboratory

Studies on recruitment of grazing molluscs and their impacts on sessile foods suggest an effective control of

overgrowth accumulating on man-made underwater structures. When various molluscs were introduced experimentally to hollow cement floats studied at Santa Barbara Marina, a comparatively sparse assemblage of chiton and limpet species appeared to minimize overgrowth. Normally, the grazers settle on structures up in the water column too rarely to control fouling community development. However, one can demonstrate dramatic effects of grazing by placing actively scraping species onto a structure before massive, sessile forms become established. One could also attempt to recruit grazers there, from the plankton, by using naturally occurring biochemical inducers of grazer settlement discovered recently in Daniel Morse's laboratory at U. C. Santa Barbara. Stomach analyses and close-up underwater listening elucidate molluscan grazing activities, which are usually hidden under the shell, and indicate that several species can feed actively on wide varieties of fouling species as the grazers develop. Adult limpets can scrape other forms away with the shell. In formal field experiments in progress for three months now, one *Collisella strigatella* per 100 sq. cm was sufficient to keep almost all macroscopic forms from colonizing. Widely foraging adult *Mopalia muscosa* chitons can remove most serpulid tube-worms that do settle near *C. strigatella*. Such studies could become as important as previous, more extensive ecological studies on insects that have been introduced to areas to control weed and pest species.

MAXIMUM SIZE AND LATITUDE: THEIR RELATION IN *Littorina planaxis* AND *L. sitkana*

Peter Frank
Biology, University of Oregon
Eugene, Oregon 97403

Littorina planaxis has a planktonic larval stage, *Littorina sitkana* develops directly. In both species growth continues through the entire life span. *L. planaxis* collections in the U.S. Museum of Natural History, ranging from Lat. 18-40°N, indicate that maximum size is attained near the extremes of the range rather than in the middle. *L. sitkana*'s range is from 44-65°N lat.; maximum sizes in this species are more characteristic of the center of its range.

This contrast is what would be expected if uncertainty of recruitment success is associated with selection for longevity, and if this uncertainty is more clearly related to marginal distribution in a planktonic than a directly developing species. I thank Dr. Joseph Rosewater for providing the data on which the comparison is based.

REPRODUCTIVE DYNAMICS IN *Cyanoplax dentiens* (Gould), A BROODING HERMAPHRODITIC CHITON

David R. Lindberg and John S. Pearce

Center for Coastal Marine Studies
University of California, Santa Cruz, CA 95064

Cyanoplax dentiens is among the few species of chitons reported to brood their young, and the only known species of hermaphroditic chiton. We found that individuals in a central California population seasonally change their sexual condition: individuals were "male" in the late summer and early fall when sperms accumulate in the gonad, simultaneous hermaphrodites in the late fall to early spring when eggs also accumulate, and "female" in the late spring and early summer, after spawning, when only relic eggs were retained in the gonad. Rare individuals more than 13 mm in length were invariably male, regardless of season. Animals maintained in isolation in the laboratory were self-fertile, and they brooded up to 3 sets of embryos between January and early March. After brooding the eggs 7-9 days, the chitons released swimming trochophores with early shell rudiments; a few of these settled on the dorsal surface of the parent. Hermaphroditism, self-fertility, and brooding all appear to be particularly appropriate reproductive attributes for these very small, widely distributed, but usually relatively uncommon chitons.

REPRODUCTIVE BIOLOGY OF *Arthritica crassiformis* POWELL AND *Arthritica bifurca* (WEBSTER), TWO COMMENSAL BIVALVE MOLLUSKS (LEPTONACEA)

Paul Chanley and Matoira Chanley

Fundacion Chile, Casilla 773, Santiago, Chile

Both species are functional hermaphrodites, incubating larvae for about one week. *Arthritica crassiformis* released 245-3074 larvae, 150 μ in length, every 11-12 days. They set at 235-270 μ . *Arthritica bifurca* released 5-5016 larvae, 124 μ in length, every 8-22 days. They set at 243-275 μ . Larger clams tended to produce larger broods.

THE REMOVAL OF *Ostrea lutaria* AND *Ostrea chilensis* FROM THE GENUS *Ostrea* ON THE BASIS OF LARVAL CHARACTERISTICS

Paul Chanley

Fundacion Chile, Casilla 773, Santiago, Chile
and

P. Dinamani

Fisheries Research Division, Wellington, New Zealand

Four species of oysters occur in New Zealand and one in Chile. Their larvae are described. *Ostrea lutaria* and *O.*

chilensis larvae differ radically from larvae of other oysters. Possibly these are primitive species and species with their type of larvae should be placed in a genus other than *Ostrea*.

LIFE HISTORY OF *Epitonium tinctum* (PROSOBRANCHIA: MESOGASTROPODA)

Amy Breyer

Rohnert Park, California

The wentletrap *Epitonium tinctum* (Carpenter, 1864) ranges along the west coast of North America from Baja California to Alaska. It is found intertidally in association with the small clonal anemone *Anthopleura elegantissima* (Brandt). Living in pockets of sand amongst the clone, this micropredator feeds on the tentacles and tubercles of the anemones. Previous studies have been related to the feeding with the exception of Bulnheim (1968) who traced the development of the unusual sperm and presented evidence of protandric hermaphroditism. Little else has been reported about this species. The present report is a description of the life cycle of *E. tinctum* based on animals from Sonoma County, California. Monthly collections from November 1977 to May 1979 indicate that the population size fluctuates seasonally. Laboratory observations reveal that these mesogastropods are protandric hermaphrodites with only one sex change during their life. Males produce atypical sperm called spermatozouga which comprises one giant apyrene sperm with thousands of normal sperm attached to the tail. Although motile, this giant "carrier" sperm is incapable of swimming from a male to a female. Lacking any copulatory organ, the males transfer the spermatozougmata to the females via the respiratory currents. The peculiar egg cases are ellipsoid sand-encrusted spheres strung along a strong thread which is attached to the substrate. Egg cases are formed in the oviduct and are completed by the foot. Sand grain size, environment and size of the female affect fecundity. Development within the egg case includes spiral cleavage and a brief trochophore stage. A planktotrophic veliger is formed at the end of seven days.

REPRODUCTION IN THE AEOLID NUDIBRANCH *Spurilla neapolitana*

Linda S. Eyster and Kevin J. Eckelbarger

Harbor Branch Foundation, Inc.
RR 1, Box 196
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Reproduction, development, and the effects of feeding and starvation on gametogenesis in *Spurilla neapolitana* are being examined in specimens from South Carolina and Florida. Throughout its range *S. neapolitana* feeds on anemones and in our experiments chose *Aiptasia pallida* over other anemones provided. Adults given food continued to feed and to oviposit. Starved adults survived 3 weeks but laid eggs for only one week after initiation of starvation. If fed after 2 weeks starvation, 59% of the specimens resumed oviposition in 8-10 days but the other 41% died.

Specimens were observed from April to June and again from October to December. Only mature individuals were

found, suggesting that reproduction may occur in all months. The egg mass is a secondarily-twisted string of white eggs with uncleaved egg diameter ranging from 77-90 μ . Eggs from both South Carolina and Florida developed into planktotrophic veligers in 4-6 days at 23°C. Other investigators have reported a change in development type induced by starvation but we have been unable to induce this change, suggesting that members of one population may be more plastic than those of another.

The ovotestes are arranged posteriorly on either side of the gut. Oocytes arise near the outer wall of the ovotestes and sperm near the lumen. Based on preliminary studies, vitellogenesis seems to be autotrophic, involving both rough ER and Golgi complexes, with a possible contribution of yolk precursors from the adjacent follicle cells, which contain dilated ER cisternae.

Spermiogenesis begins with a flattening of the nucleus along the antero-posterior axis, the appearance of fibrillar chromatin at the posterior pole and condensed chromatin plaques along the anterior and lateral regions of the nuclear envelope. The nucleus becomes ellipsoidal; a centriole and accompanying flagellar axoneme migrate into a posterior depression in the nucleus. During further differentiation, the nucleus elongates with the chromatin appearing as closely packed longitudinally-arranged fibrils. The tail is enclosed in a mitochondrial sheath and a single helical keel containing a glycogen-like material. The mature sperm is filiform with a banana-shaped nucleus and no apparent acrosome.

Copulation is reciprocal and simultaneous. Allosperm received from copulation are stored with their heads embedded in the seminal receptacle wall. The wall is lined with both cilia and unbranched microvilli. No junctional complexes were observed between the sperm and the cells of the receptacle wall.

REPRODUCTIVE BIOLOGY OF *Modulus* modulus LINNAEUS, 1758 (PROSOBRANCHIA: CERITHIACEA)

Richard S. Houbriek
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Modulus modulus has open pallial gonoducts and apallial males. Fertilization is internal and is effected by spermatophores that contain eupyrene and apyrene sperms. The life cycle of a population from Fort Pierce, Florida, lasts about one year. Mating occurs in early winter and spawning in spring. Females have complex pallial oviducts and ovipositors. Spawn masses are cylindrical, comprised of gelatinous tubes and deposited on marine grasses. Development is direct, i.e., all stages of larval development take place within the egg capsule. Young snails emerge after three weeks of incubation.

LIFE HISTORY OF THE MANGROVE GASTROPOD *Thais kioskiformis* DUCLOS, 1832 ON THE PACIFIC COLOMBIAN COAST

**Jaime R. Cantera K., Rafael Contreras R., Francisco
Borrero, Elisabeth Buttkeus, and Fernando Zapata**
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Thais kioskiformis is a common predator of oysters, cirripeds and other gastropods, which inhabits the roots and trunks of red mangrove, rocky shores and man-made structures from Baja California to Peru including localities in Colombia within mangrove ecosystems from Ensenada of Catrpe (4° 25' N and 77° 18' W) to Tumaco (1° 50' N and 78° 44' W). The average length of specimens from six localities was 36.36 mm. *Thais kioskiformis* preys upon cirripeds, and the mollusks *Ostrea conchaphila*, *Littorina zebra*, *L. varia*, and *Cerithidea valida*. Ovipigerous masses can be round or elongated, with length between 5.0-23.0 cm; width between 7.9-9.8 cm. The cylindric capsules average 5.54 × 2.1 mm. The females deposit the masses individually or communally on shaded surfaces (under trunks). The growth was, in average, 0.54 mm in length and 0.29 gr. in weight by month. This work includes a description of copulation, oviposition, development, and population variations according to the method of modal variations during a one year period. A study of morphological and morphometric changes of the shell and the radula growth, by means of the regression analysis method are included.

SEXUAL PHASES AND PLANKTONIC LARVAL DEVELOPMENT OF THE AMERICAN OYSTER *Crassostrea virginica* (GMELIN), FROM COASTAL LAGOONS OF SOUTHEAST MEXICO

**Antonio García-Cubas, Patricia Rogers and Emilia
Chávez**
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Se analizan quinientas muestras periódicas a nivel histológico sobre la evolución gonádica del ostión. Ilustrándose con gráficas e histogramas de cada fase en relación con salinidad y temperaturas ambientales. Asimismo, se estudia la duración del desarrollo embrionario y larvario planctónico en condiciones controladas de laboratorio, cuya duración es de dos a tres semanas, la fijación y metamorfosis se efectúa en la última semana de vida planctónica.

Reproduction of the American oyster *Crassostrea virginica* has been studied on the Atlantic coast of United States, but there exist no records of its reproductive biology in Mexico. The present study was conducted to determine the reproductive biology of *C. virginica* in the southeastern region of Mexico where there is intention to cultivate this oyster.

During three annual cycles, a histological analysis of the gonads of *C. virginica* from the Boca de Atasta area of the Terminos Lagoon, indicated the presence of four gonadic phases with intermediate stages in each phase

The four gonadic phases identified were: Phase One or undifferentiated; Phase Two or gametogenesis; Phase Three or reproduction; and Phase Four or post-spawning.

Two massive spawnings were defined. The first was in the spring, from March to May, when the average temperature was between 28° and 29° C and the average salinity was 28 to 29°/oo. The second spawning occurred during the period from September to November, occasionally extending to December and January.

The average temperature during this latter period was 27 to 28° C, with salinities of 8 to 9°/oo. This second period corresponds to the rainy season, with consequently low temperatures and salinities.

Knowing the periods of major natural spawnings, a study was then started on the embryology and larval development under controlled laboratory conditions similar to those found in the natural habitat of the oyster.

Under these conditions, with average salinity of 20°/oo and average temperature of 30° C, the stages through which the oyster larvae passed have the following characteristics:

Stage	Size	Time
a) Veliger, straight-hinge or "D" shaped larvae	70 x 55 μ 80 x 75 μ	15-36 hours
b) Early umbo larvae	93 x 92 μ 120 x 130 μ	36-60 hours
c) Umbo latter larvae	155 x 165 μ 200 x 205 μ	60 hours-7 days
d) Mature larvae with eyespot	275 x 280 μ 300 x 304 μ	10 - 16 days

This information was compared with that provided by Chanley and Andrews (1971), and we conclude that larval development from the veliger stage to mature larvae occurs more rapidly in tropical waters than in colder waters, the difference being about a week.

SEXUAL MATURITY, GONADAL AND LARVAL DEVELOPMENT OF THE BRACKISH WATER CLAM *Rangia cuneata* (GRAY, 1831), IN TERMINOS LAGOON, CAMPECHE, MEXICO

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Se describe la evolución gonádica mediante técnicas histológicas durante veinte y siete meses de muestras mensuales. Se ilustra gráficamente cada una de las fases en relación con parámetros ambientales de temperatura y salinidad. Identificándose dos períodos de desoves masivos anuales. Se estudió la secuencia embrionaria y ciclo larvario en condiciones controladas de laboratorio.

The brackish water clam *Rangia cuneata* is encountered in the Pom Lagoon, in southeastern Mexico, an area which has been intensively exploited. The present study was

undertaken in order to determine the reproductive biology of *R. cuneata* in this specific region.

A histological analysis of the gonads of the clam was made during twenty seven months resulting in the identification of four gonadic phases.

Throughout the study, the sexual elements of this species were identified. In the study area there does not exist a true winter which would permit the gonadic cycle to enter repose, indicating that the temperature is an important element for the gonadic cycle of this species.

Two massive spawnings were detected; the first occurred from April to May, with an average temperature of 29° C and average water salinity of 5.5°/oo; the second massive spawning was in the autumn from September to October, the average temperature was 28° C and salinity 3-0°/oo.

Having established the major massive spawning of the clam a study of the embryonic cycle and larval development was initiated under controlled laboratory conditions with an average salinity of 5°/oo and average temperature of 30° C as in the natural environment.

Under these conditions, the stages through which the clam larvae passed have the following characteristics:

Stages	Size	Time
a) Veliger, straight-hinge or "D" shaped larvae	90 x 85 μ	40-60 hours
b) Early umbo larvae	120 x 116 μ 150 x 144 μ	60 hours-3 days
c) Umbo latter larvae	175 x 165 μ 200 x 196 μ	3-5 days
d) Mature larvae with statocyst	300 x 304 μ	5-12 days

LIFE HISTORY EVOLUTION IN TEMPORARY VERSUS PERMANENT PONDS: *Lymnaea palustris* and *L. stagnalis*

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Demographic sampling and field experiments showed that *L. palustris*, the species found in vernal ponds, was not more r-selected than its congener in more permanent ponds. It instead has adapted to an uncertain environment by evolving a flexible age and size interval for first reproduction, and sequencing reproduction to pond phenology. Field experiments showed that adult fecundity was not severely limited in *L. stagnalis*, but juvenile growth rates were. These results indicate the juvenile mortality (which may be as high as 99% of the cohort) may be just as important a selective force as density dependent reductions in adult fecundity. Field experiments on *L. palustris* in temporary ponds showed that density has significant effects on both growth and fecundity. Estimates of adult densities also indicate that density dependent limitation of reproduction may occur in this species. These results therefore suggest that density dependence is a stronger selection force, at least on adult fecundity, in temporary habitats.

GEOGRAPHIC DISTRIBUTION OF BREEDING SYSTEMS IN FRESHWATER BIVALVES (UNIONACEA) IN EASTERN NORTH AMERICA

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The larvae of freshwater unionacean bivalves (glochidia) are retained with the gills of the female for varying lengths of time prior to completion of an obligate symbiotic phase on a vertebrate host. There are two patterns of glochidial retention in eastern North America: short-term breeders retain glochidia for a brief period of time in early summer and long-term breeders retain glochidia for an extended period of time over the winter. The breeding systems do not differ in overall taxonomic diversity or broad geographic distribution, but there is a significant association between the proportion of long-term breeders in a river and latitude ($r^2 = .772$; $P < .001$). This relationship is believed to reflect life history adaptations to the harsh climates of northern latitudes. Virtually the entire growing season precedes the period of glochidial retention in long-term breeders but short-term breeders retain glochidia early in the season before the female has had the opportunity to prepare for the stresses associated with this phase of the life cycle. Furthermore, glochidia of long-term breeders metamorphose to the juvenile stage in early summer and have an extended period of growth in their first year whereas the late summer-early fall metamorphosis in juveniles of short-term breeders abbreviates the length of their first year growth period.

ASPECTS OF EARLY DEVELOPMENT IN A LAND SNAIL, *Anguispira alternata*

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Cleavage is total and nearly equal. A coeloblastula is formed; gastrulation is by invagination. A precocious pharynx, one of the earliest of the visible differentiations, serves to transport surrounding nutrient fluid to the archenteron from which the fluid becomes incorporated in the vacuoles of large-celled endoderm. The shell gland is functional by the time the foot makes its appearance. The embryonic foot includes the distal podocyst and the foot proper. The podocyst, by coiling and uncoiling, aids in distribution of materials; subsequently it is shed. The earliest indication of eye formation is the aggregation of cells, presumably ectodermal in origin, lateral to the organizing cephalic ganglia. The aggregating cells form a sphere of columnar cells into the center of which the lens is secreted. By this time the forming ocular tentacles are evident as eminences; the developing eye is incorporated into the distal region of the organizing tentacle. There is no indication of formation of the early eye vesicle by invagination from the surface epithelium, as has been described for other pulmonates.

CONTRIBUTED PAPER:

HAWAIIAN CHROMODORIDS

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There are 22 species of chromodorids in the waters around the island of Oahu, Hawaii. One species, *Chromodoris lilacina* (Gould, 1852), occurs primarily in the littoral or intertidal zone. Four species seem to occur both subtidally and intertidally: these are *Chromodoris imperialis* (Pease, 1860), *C. peasei* (Bergh, 1880), *C. trimarginata* (Winckworth, 1946), and *C. albopustulosa* (Pease, 1860). The remaining 17 chromodorid species all occur predominantly in subtidal depths. These subtidal species show a three-dimensional partitioning of the habitat space: each species occurs only at certain localities, and each species has a definite depth distribution. Some of the species attain further niche separation by different feeding preferences.

Nine of the chromodorid species are apparently endemic to the Hawaiian Islands. The species presently known only from the Hawaiian Islands include 5 undescribed species, *Babaina daniellae* (Kay & Young, 1969), *Hypselodoris lineata* (Eydoux & Souleyet, 1852), *H. vibrata* (Pease, 1860), and *C. peasei*. The other 13 species are Indo-Pacific in distribution.

A grant from Earthwatch provided the necessary funds and volunteers that made possible the collection of specimens during the summers of 1978 and 1979.

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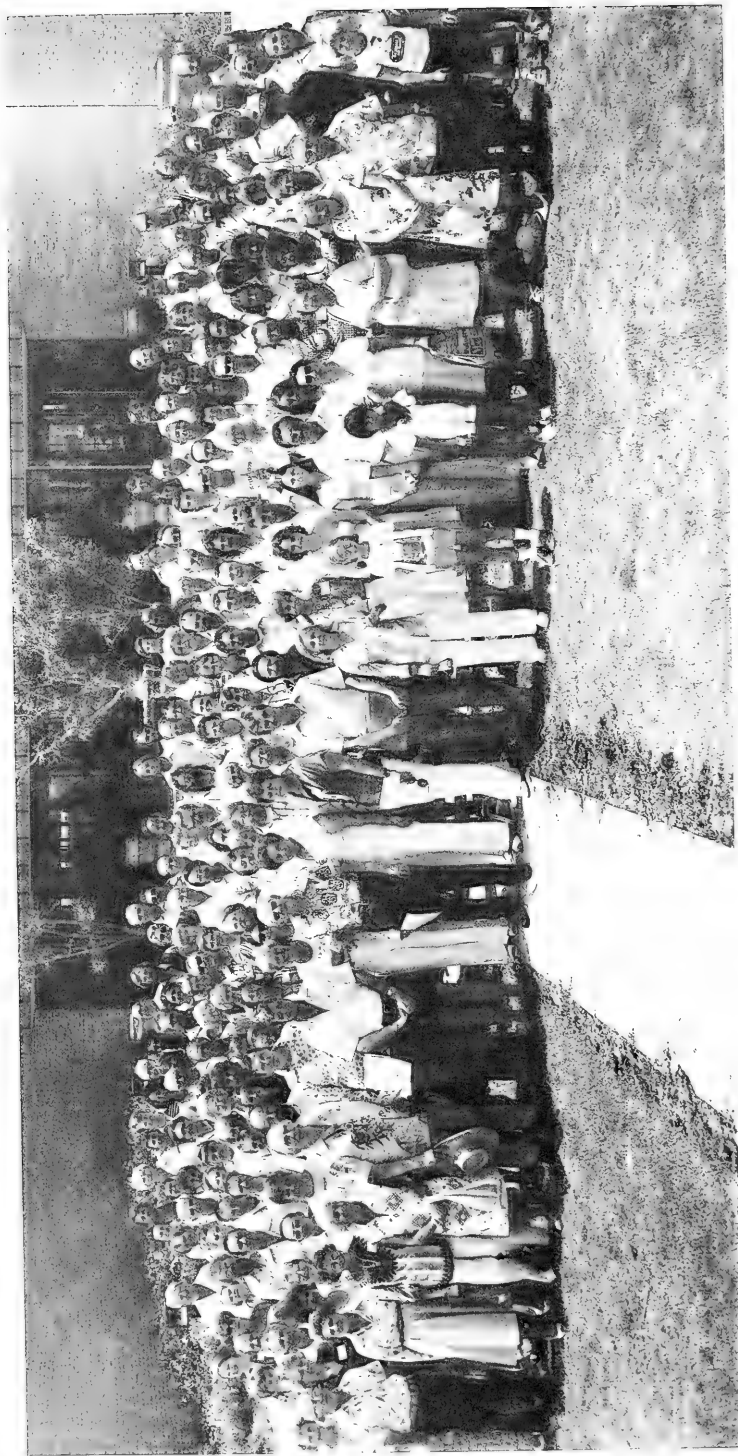
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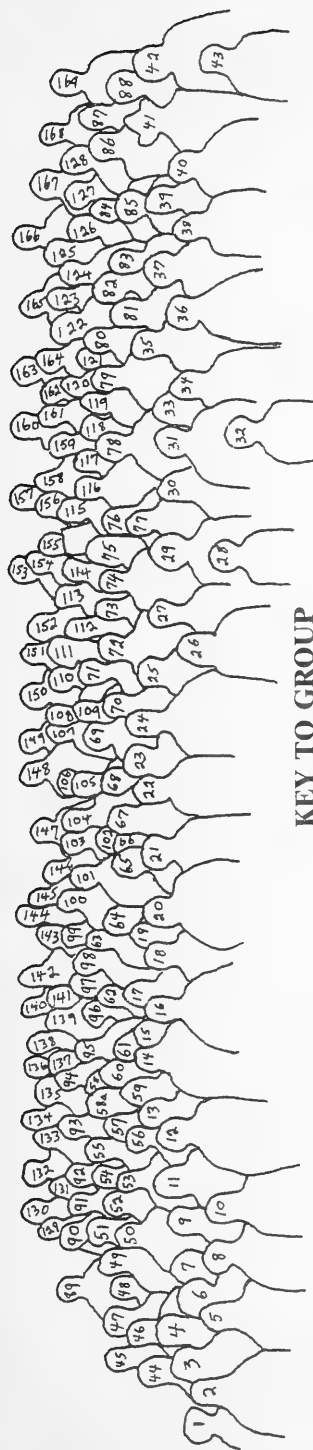
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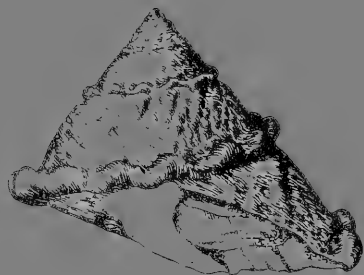
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THE WESTERN SOCIETY OF MALACOLOGISTS

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The **Annual Report** of the Western Society of Malacologists is based on its yearly meeting. Distribution of the **Annual Report** is free to regular and student members who are, at the time of issue, in good standing. Membership dues are \$7.50 and \$3.00 for students. Others of a regular member's family may join for an additional \$1.00; each family receives only one **Annual Report**.

The Western Society of Malacologists has issued two **Occasional Papers**—No. 1, “‘Sea Shells of Tropical West America’: Additions and Corrections to 1975” by Myra Keen & Eugene Coan; and No. 2, “A Catalogue of Collations of Works of Malacological Importance” by George E. Radwin & Eugene Coan. Each was priced at \$2.50. The first is now out of print; the second is still available.

Correspondence regarding membership and orders for additional or back issues of the **Annual Report** or the **Occasional Papers** should be addressed to the current W.S.M. Treasurer, Mrs. Raymond D. (Kay) Webb, 501 Anita St., #186, Chula Vista, Calif. 92011.

When full-length papers are included in the **Annual Report** or **Occasional Papers** they are reviewed by two members of the Editorial Board in addition to the Editor.

NOTICE OF THE 14th ANNUAL MEETING OF THE WESTERN SOCIETY OF MALACOLOGISTS

The 1981 meeting of the Western Society of Malacologists will be held at San Diego State University, San Diego, California, 23–26 June. The WSM program will include the annual shell auction, reprint exchange, exhibits, symposia on west American biogeography and opisthobranch research, and contributed papers. Advance registration is strongly encouraged.

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c/o Miss Bonnie B. Williams, Treasurer
Route 1, Box 333H
Corning, California 96021
(Meets twice a month: second Wednesday at 9:30 a.m. in members' homes, and last Wednesday at 7:30 p.m. in Jay E. Partridge School, Room 1, East Avenue, Chico, California)

Conchological Club of Southern California

c/o Malacology Section
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, California 90007
(Meets in Museum Lounge, 7:30 p.m., first Monday of every month, unless a holiday, then on Wednesday of same week)

Hawaiian Malacological Society

P.O. Box 10391
Honolulu, Hawaii 96816
(Meets first Wednesday of every month, 7:30 p.m., Hawaii National Guard Headquarters, Diamond Head Road & 22nd Avenue, Honolulu. December Christmas party at another location)

Houston Conchology Society

c/o Constance Boone
3706 Rice Boulevard
Houston, Texas 77005
(Meets fourth Wednesdays of August, September, October, January, February, March, April and May, third Wednesday of November, at the Houston Museum of Natural Science)

Long Beach Shell Club

600 Long Beach Boulevard (YMCA Building)
Long Beach, California 90812
(Meets second Sunday of every month except July, 2:00 p.m.)

Northern California Malacozoological Club

P.O. Box 1249
El Cerrito, California 94350
(Meets third Thursday of each month, alternation between California Academy of Sciences and El Cerrito Fairmont Recreation Center)

Oregon Society of Conchologists

Dr. Myron W. Travis
4324 NE 47th Avenue
Portland, Oregon 97218
(Meets first Sunday of each month, 1:30 p.m., in private homes; announcements given in monthly paper or by card)

Pacific Northwest Shell Club

c/o Mrs. Wilma G. Young, Corresponding Secretary
P.O. Box 1931
Seattle, Washington 98111
(Meets third Sunday of each month, 2:00 p.m., Lake City Christian Church, 1933 NE 125th Street, Seattle)

Pacific Shell Club

c/o Malacology Section
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, California 90007
(Meets in Museum Lounge, first Sunday of each month, 1:30 p.m., October through June.)

San Diego Shell Club

c/o Carole Hertz
3883 Mt. Blackburn Avenue
San Diego, California 92111
(Meets third Thursday of every month, Casa del Prado, Balboa Park)

Santa Barbara Malacological Society

P.O. Box 30191
Santa Barbara, California 93105
(Meets third Friday of every month, 7:30 p.m., Santa Barbara Museum of Natural History, 2559 Puesta del Sol)

Southwestern Malacological Society

c/o Mrs. Carol C. Skoglund
3846 E. Highland Avenue
Phoenix, Arizona 85015
(Meets third Wednesdays, September through May, 7:30 p.m., Asbury United Methodist Church, 1601 West Indian School Road, in auxiliary rooms)

Yucaipa Shell Club

c/o Mousley Museum of Natural History
Bryant Street & Panorama Drive
Yucaipa, California 92399
(Meets third Sunday of every month except August, 2:00 p.m., in the Museum)

TREASURER'S REPORT

Period Covered: September 1, 1979 thru 7-15-80
(Books closed for 1979-1980 Society Year)

Received from Past Treasurer, Carol Skoglund as of September 1, 1979

\$2294.05

INCOME

Dues:

1978	1 Regular	\$ 7.50	
1979	6 Regular	45.00	
1979	1 Family	8.50	
1980	157 Regular	1177.50	
1980	22 Family	187.00	
1980	17 Student	51.00	1476.50

Publication:

Annual Reports			
1	@ \$2.50	2.50	
10	@ \$5.00	50.00	
2	@ \$7.50	15.00	
Occasional Paper #2			
4	@ \$2.50	10.00	77.50

DONATIONS. (To Student Grant)

Amer. Mal. Union		100.00	
Beatrice Burch		5.00	105.00

Savings Account Interest:

9-1-79 thru 6-26-80		92.59	92.59
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Convention Related Income:

Group Photo		30.00	
Shell Auction Receipts		546.00	
Banquet & Food		500.00	1076.00 2827.59 \$5121.64

EXPENSES

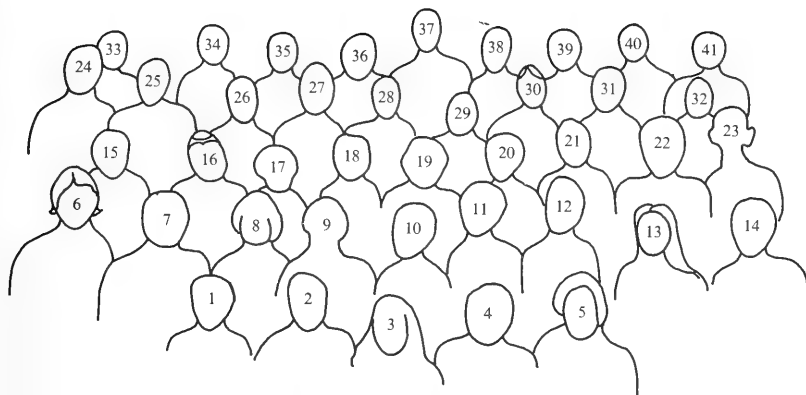
Secretary Expenses		\$ 44.42	
Treasurer Endorsement Stamp		6.86	
Treasurer's Yearly Expense		35.79	
Editor Expenses 1979		12.34	
Membership Drive		66.20	
Filing Fee Non-Profit Organization			
State of California		2.50	
Print Stationery		87.98	
A.M.U. Annual Dues		13.00	
President's Yearly Expenses		147.64	
Annual Report: Typeset, Print & Mail		1631.43	
Group Photo—Convention		30.48	
Convention (Banquet & Food)		578.76	2657.40

AUDITING COMMITTEE

Susan Gray Marelli			\$2464.24
Jean DeMouthe Smith			
Peter U. Rodda			
	Balance end of period		
	Present distribution:		
	Checking	\$788.60	
	Savings	<u>1675.64</u>	
			\$2464.64

Kay Webb, Treasurer





KEY TO GROUP PHOTOGRAPH

- | | |
|------------------------|------------------------|
| 1. Myra Keen | 22. Paul Scott |
| 2. David Mulliner | 23. Gene Coan |
| 3. Vida Kenk | 24. Roy Poorman |
| 4. Bill Pitt | 25. Bruce H. Fowler |
| 5. Carol Skoglund | 26. Helen DuShane |
| 6. Mark Eutenier | 27. Patrick LaFollette |
| 7. Mary Larson | 28. Samuel Johnson |
| 8. Dee Dundee | 29. Jo Ramsaran |
| 9. Billie Mabry | 30. Timothy Pearce |
| 10. Edith Abbott | 31. Jeff Barksdale |
| 11. Lois Pitt | 32. Harold Hunt |
| 12. Judy Terry Smith | 33. James McLean |
| 13. Kathleen R. Dwyer | 34. Martin Wolterding |
| 14. Katharine Stewart | 35. Bill Emerson |
| 15. Bert C. Draper | 36. David Lindberg |
| 16. Beatrice L. Burch | 37. Dan Marelli |
| 17. Kate St. Jean | 38. Barry Roth |
| 18. Twila Bratcher | 39. Michael Kellogg |
| 19. Gladys Weber | 40. Bill Old |
| 20. Forrest Poorman | 41. George Kennedy |
| 21. Susan Gray Marelli | |

Others attending, but not in picture: Elmo Adams, John Allen, Glenn Burghardt, Walter Carr, Victor Chow, Anthony D'Attilio, Larry Eng, Theodore Foin, Carole Hickman, Audrey Holliman, Wayne Holliman, Bill Keeler, Edwin Mastro, Tom Morris, Elizabeth Nesbitt, Peter Rodda, Lee Schemp, Ray Sommers, Alice Williams, and Bonnie B. Williams.

MINUTES, EXECUTIVE BOARD WESTERN SOCIETY OF MALACOLOGISTS

University of California, Davis, California

23 June 1980: 6:55 P.M.

The meeting was called to order by President Dr. Vida Kenk, those present were Dr. Myra Keen, Dr. Barry Roth, Mrs. Helen DuShane, Mrs. Carol Skoglund, Mr. David Mulliner, Dr. Eugene Coan and Mr. William Pitt.

Minutes of the 1979 board meeting were read and approved as read.

The Treasurer's report was read by Mrs. Carol Skoglund who reported a balance on hand as of May 31, 1980 of \$1986.61. A motion to accept the report was made by Mrs. Carol Skoglund and was seconded by Mr. David Mulliner. The motion carried.

A letter was read from the Conchologists of America inviting us to become a member of their organization.

A letter was read from Mr. Donald Young of Florida requesting that we send him a club emblem to put in a display of club emblems in shell shows.

A letter was read from The Florida State College Museum requesting that individuals with collections of 5,000 lots or more send data for future reference to these collections.

A letter was read from The University of Colorado Museum. They want information on large collections, institutional and private, that may be unwanted, unused, or for disposal after death of the owner.

The two letters concerning collections were discussed and it was decided that we make an announcement about them at the annual business meeting.

The letter from COA inviting us to join their organization was discussed. It was decided that we should become members and the Secretary was instructed to write and see if we could join as a Scientific organization rather than as a shell club.

The letter from Mr. Donald Young concerning the sending of our emblem to enter in shell shows was discussed and it was decided that we should not participate.

Dr. Eugene Coan reported on the membership drive which he conducted. He reported sending 300 letters and we received 29 new members.

The problem of delinquent members was discussed and the Secretary was instructed to send reminders.

President Dr. Vida Kenk presented a membership application form for board approval. It was moved that we accept the form by Mr. William Pitt and seconded by Dr. Barry Roth. It was approved as corrected.

President Dr. Vida Kenk brought up the subject of a possible reduction in dues for senior members. It was discussed and rejected.

Dr. Barry Roth read the report of the nominating committee which presented the following slate of officers.

President	Mrs. Carol C. Skoglund
1st Vice President	Dr. Donald R. Shasky
2nd Vice President	Mr. David R. Lindberg
Secretary	Mr. Bruce H. Fowler
Treasurer	Mrs. Catherine M. Webb
Member-at-Large	Mr. Ernest S. Haight
Member-at-Large	Dr. Carole S. Hickman

Mrs. Carol Skoglund reported on a possible meeting place for 1981. It was not possible to meet at U.C. Santa Barbara as was suggested last year and as an alternative site she suggested San Diego State University from June 22-26, 1981. It was moved that we accept this site by Mr. William Pitt and seconded by Mr. David Mulliner. The motion carried.

Mrs. Carol Skoglund moved that we authorize the Editor to print 300 copies of the annual report at an estimated cost of \$2,000.00. It was moved that we accept the motion by Mrs. Carol Skoglund and seconded by Mr. David Mulliner. The motion carried.

Mr. David Mulliner moved that we award a \$500.00 research grant at the 1981 meeting. It was moved that we grant the award by Dr. William Emerson and seconded by Mrs. Carol Skoglund. The motion carried.

As there was no further business to come before the board the meeting was adjourned.

MINUTES, ANNUAL BUSINESS MEETING WESTERN SOCIETY OF MALACOLOGISTS

University of California, Davis, California

25 June 1980: 4:15 P.M.

The meeting was called to order by President Dr. Vida Kenk.

The minutes of the 1979 Executive Board and General Meeting were approved as printed in the annual report.

The Treasurer's report was read by Mrs. Carol Skoglund who reported a balance on hand of \$1986.61.

President Dr. Vida Kenk read letters from Florida State University Museum and the University of Colorado Museum concerning the location of and deposition of large institutional or private collections.

Mrs. Carol Skoglund presented San Diego State University as a site for our next meeting with a tentative date of June 22-26, 1981. Dr. Eugene Coan moved that we accept this site and date. It was seconded by Dr. William Emerson. The motion carried.

Dr. Eugene Coan reported on the student awards as presented by the AAAS-PD.

1st award, \$100.00—Mr. David Lindberg

2nd award, \$50.00—Mr. Tom Morris

President Dr. Vida Kenk reported that the Society would award a student research grant of \$500.00 for the year 1981.

President Dr. Vida Kenk reported that the auction cleared \$547.00

President Dr. Vida Kenk reported that Dr. James McLean brought our display cases from the Los Angeles County Museum in a borrowed truck. She asked that the Society pay the cost of the gasoline. It was moved that the Society do so by Mrs. Carol Skoglund and seconded by Mr. Patrick LaFollette. The motion carried.

Dr. Barry Roth read the report of the nominating committee which presented the following slate of officers.

President.....	Mrs. Carol C. Skoglund
1st Vice President	Dr. Donald R. Shasky
2nd Vice President.....	Mr. David R. Lindberg
Secretary.....	Mr. Bruce H. Fowler
Treasurer.....	Mrs. Catherine M. Webb
Member-at-Large	Mr. Ernest S. Haight
Member-at-Large	Dr. Carole S. Hickman

There were no nominations from the floor and the slate of officers was elected by a unanimous vote.

President Dr. Vida Kenk presented the gavel to the incoming president Mrs. Carol Skoglund.

President Mrs. Carol Skoglund thanked Past President Dr. Vida Kenk for the wonderful meeting.

As there was no further business the meeting was adjourned.

THE BIOLOGICAL CONTRIBUTIONS OF JAMES GRAHAM COOPER

Eugene Coan

Research Associate, Department of Geology
California Academy of Sciences
Golden Gate Park,
San Francisco, California 94118

A biography, now in press, presents an account of the colorful life of James Graham Cooper, together with a bibliography of his papers and books and an analysis of his new taxa. Cooper made major contributions in a variety of scientific disciplines, including ornithology, malacology, geography, and botany, as well as significant contributions to paleontology, ichthyology, herpetology, mammalogy, and biogeography.

He introduced 138 new zoological taxa, of which 119 are both available and recognizable. Taxa were introduced in the mollusks, fish, birds, brachiopods, reptiles, insects, and mammals. A search for the type material of his 114 available species has shown that about half are now represented by either original material or by neotypes. An analysis of the taxonomic units he made available shows that some 63% of them are now considered valid (with an additional 4% being recognized units under replaced homonyms).

Siphonium, AN OVER-USED NAME IN MOLLUSCA

A. Myra Keen

Geology Department, Stanford University
Stanford, California 94305

Siphonium is a pre-Linnean name introduced into Mollusca by Gray, 1850, for a gastropod genus in the family Vermetidae. Although used by authors for many years, the name proved to be preoccupied by *Siphonium* Link, 1807. Link's *Siphonium* was a fossil cephalopod, validly enough proposed but now unidentifiable. A yet earlier usage of the name *Siphonium*, as of Browne, 1789, is cited by at least one nomenclator. However, Browne's work is generally rejected as non-bionomial. This *Siphonium*, if it were to be accepted, would have to fall as a synonym of *Teredo* Linné, 1758, a bivalve or pelecypod genus.

UMBILICAL BROOD PROTECTION AND SEXUAL DIMORPHISM IN THE BOREAL PACIFIC TROCHID GASTROPOD

Margarites vorticerus DALL

David R. Lindberg and Ross A. Dobberteen

Center for Coastal Marine Studies
University of California
Santa Cruz, California 95064

Specimens of *Margarites vorticerus* Dall collected at Attu Island, Alaska, during July of 1979, were found brooding eggs and young in the umbilicus. The number of developing young in each brood ranged between 471 and 3264. Each brood contained several developmental stages

including uncleaved eggs, unhatched embryos, hatched protoconch-bearing juveniles and two distinct juvenile size classes. The umbilicus of *M. vorticerus* is significantly (t -test; $p < 0.001$) larger in female specimens than in male specimens. *Margarites vorticerus* is the largest member of the genus found at Attu and the only member known to brood its young.

COLLECTING MOLLUSKS IN ECUADOR

William Pitt

2444 38th Avenue
Sacramento, California 95822

Carol Skoglund and Lois & William Pitt collected the intertidal molluscan fauna from Cabo Pasado, Canoa, Bahía de Caraquez, Punta Ancon, the Salinas peninsula and Playas, Ecuador, from 15–22 February 1980.

Conditions at the collecting sites varied as did the fauna. We found *Turbo magnificus* Jonas, 1844, and *Astraea babelis* (Fischer, 1874) at Punta Ancon. *Olivella columellaris* (Sowerby, 1825) was common at most sites. We did not find what we considered to be a large number of species or a large number of specimens of many species at any site except *O. columellaris*. To our surprise we found very few turrids that are so common in Panama.

It would not be fair to base any conclusions regarding the conditions in Ecuador on a single trip, but perhaps being situated in a zone between the North Equatorial and South Equatorial currents and not having a great tidal fluctuation is responsible for this condition.

The fauna of Miocene mollusks at Quebrada Camarones, Esmeraldas Prov., was described by Losson, 1964. There are about 150 reported species from this locality plus quite a number of unreported or undescribed species. The site is a cliff about 25 meters high and nearly vertical. The most prolific strata are near the top and are collected from blocks that fall. There appear to be several strata, but these are difficult to reach and are partially covered by a talus.

The Miocene fauna here appears to be from a moderate depth. The most common species here is a *Phos*. Other genera include *Cancellaria*, *Natica*, *Calliocten*, *Neosconia*, *Polystira*, *Trophon*, etc.

AM-MELA EXPEDITION TO THE SOLOMON ISLANDS

Twila Bratcher

8121 Mulholland Terrace
Hollywood, California 90046

The Am-Mela (American-Melanesia) Expedition chartered the boat, Coralita, for scuba-diving, snorkling, and dredging for mollusks in the Solomon Islands. Many night dives were made on both sand and coral substrate. Nudibranchs were found at all depths. Water temperatures at all stations to a depth of 40 meters were 29° to 30°C. Stations ranged over an area from Honiara, Guadalcanal, to the atoll of Ontong, Java, which is 5° south of the equator.

GENETIC AND ECOLOGICAL DIVERGENCE BETWEEN SIBLING SPECIES OF *Littorina* FROM THE CALIFORNIA COAST

Edwin Mastro and Victor Chow

Bodega Marine Laboratory
University of California,
Bodega Bay, California 94923

The introduction of biochemical techniques to modern taxonomic procedures has confirmed the presence of numerous sibling species whose identities were originally suspected on the basis of slight differences in morphological, cytological, or ecological characters. Within the taxon *Littorina scutulata* Gould, 1849, a dimorphism of genitalia occurs among males, and individual females produce one of two morphologically distinct types of egg capsules (Murray, The Veliger 21: 469, 1979). Biochemical analyses of five geographically distinct populations revealed that these characters are indicative of two species. Starch gel electrophoresis was carried out for fourteen enzymes, and different alleles for five of these enzymes (esterase, lactate dehydrogenase, phosphoglucose isomerase, phosphoglucose mutase, sorbitol dehydrogenase) indicated that these two sibling species are genetically isolated. These allelic differences also made possible the division of the appropriate males and females into the two separate species. These sympatric species are further distinguished by subtle morphological and ecological differences (including differences in population structure, growth rates, size at the onset of reproduction, and length of the spawning season).

COMPARATIVE MORPHOLOGY AND SYSTEMATICS OF TWO SPECIES OF *Transennella* (BIVALVIA: VENERIDAE)

Susan Gray

Department of Invertebrate Zoology
California Academy of Science, Golden Gate Park
San Francisco, California 94118

The genus *Transennella* on the central California coast is represented by two morphological varieties whose systematic status is in question. Examinations of both external and internal morphology, plus ecological observations, support the separation of the varieties into two distinct species. The species are very similar in appearance, but can be separated by characteristics of both shell and soft part morphology. Both species exhibit variation in the digestive system, a condition not previously reported in the literature.

THE TOPOGRAPHY, FORMATION, AND ROLE OF THE HOME DEPRESSION OF THE LIMPET *Collisella scabra* (GOULD)

Kathleen R. Dwyer and David R. Lindberg

Center for Coastal Marine Studies, University of California
Santa Cruz, California 95064

The topography and occurrence of home depressions

(home scars) rule out their formation solely by the previously proposed mechanisms of radular excavation or abrasion of the substratum by the shell edge. We have histochemically identified and characterized secretions from the foot (acidic mucopolysaccharides) and mantle edge (acidic mucopolysaccharides and carbonic anhydrase) of the limpet *Collisella scabra* that are capable of causing dissolution of calcium carbonate substrata. We believe that these secretions serve as a template for the radular excavation of the home depression, and that their ability to cause dissolution aids in home depression formation on certain substrata. If the substratum is harder than the radular teeth or does not undergo dissolution, *C. scabra* conforms its shell edge to the substratum.

The pedal glands that secrete acidic mucopolysaccharides have been previously reported in patellacean limpets that form home depressions, as well as those that do not. We believe that the ability to form a home depression is conditional on acquisition of homing behavior, and that once a limpet or other mollusc with acidic mucopolysaccharide secretions invariably returns and adheres to a specific area, these secretions will impregnate the substratum. If the substratum undergoes dissolution a home depression will be formed. The rate of formation and the complexity of the depression will depend on the mineralogy of the substratum, but would be increased by the mollusc's acquiring a second behavior of removing the softened material with the radula.

The similarity of home depressions among prosobranch taxa suggests that this mechanism of formation may be common. The home depression of the pulmonate limpet, *Trimusculus reticulatus*, on calcium carbonate substrata is covered with radular striations, and its pedal gland system is very similar to that found in *C. scabra*. Home depression forming members of the families Siphonariidae, Hipponicidae, Coralliophilidae, Capulidae, Calyptraeidae, and Haliotidae may also use this method.

The primary role of the home depression appears to be resistance to dislodgment rather than desiccation as evidenced by the persistence of home depressions in subtidal habitats. When on its home depression, *C. scabra* is virtually immovable. The crenulated edge of the shell and the home depression function like a lock and key and completely prohibit lateral movement. This renders the limpet less vulnerable to prying and stabbing predators such as shore birds and fish. In addition to protection from predation, the home depression may allow smaller species to co-occur on the territories of larger agonistic species (i.e., *Lotia gigantea*) by prohibiting their removal from the substratum by shoving.

AN ENERGY BUDGET APPROACH TO DIFFERENCES IN LIMPET SHELL MORPHOLOGY

Samuel E. Johnson

The Nature Conservancy
987 Jed Smith Drive
Sacramento, California 95819

Although gastropod shell morphologies differ widely within and between taxa, the reasons for these differences are not always clear. The use of energy budget equations to analyze heat and mass transfer between *Collisella digitalis*

(Rathke, 1833) and *C. scabra* (Gould, 1846) and their environment allows for quantification of shell morphology differences and leads to a partial explanation of the function of shell shape, color, ornamentation and orientation in determining limpet distribution and abundance. The more rugose shells of *C. scabra* have higher convection coefficients and lower emissivities and absorptivities than *C. digitalis* shells. Wind tunnel studies with schlieren photography indicate that *C. digitalis* shells produce less cavitation in unidirectional flows than *C. scabra* shells. Using energy budget approaches a model predicting the effect that slight changes in shell morphology, orientation or environmental factors have on limpet body temperature and behavior has been developed. Combining energy budget analyses with physiological and microclimatic information makes it possible to develop a climate space for each species and to examine quantitatively differences in their "fundamental" niches.

FILTERING THROUGH SPECIES LISTS FOR SIGNIFICANT DISTRIBUTION PATTERNS IN WEST MEXICAN AND CARIBBEAN COGNATES

Judith Terry Smith

1527 Byron Street
Palo Alto, California 94301

Vermeij (1978) listed 279 pairs of living molluscan species and subspecies from the Caribbean and Pacific-Panamic, an important step toward obtaining finer details on the distribution of cognate forms. Woodring (1966, Amer. Philos. Soc.) recognized a Tertiary Caribbean Province characterized by genera and subgenera he termed *Paciphile* or *Caribophile* on the basis of their modern, more restricted distributions. The Caribbean has several sub-provinces: Gulf of Mexico, Caribbean south of the Hispaniola arc, western Atlantic off Brazil, subdivisions or combinations of these. The *Caribophile Nodipecten nodosus*, s.s. ranged from Venezuela to the central Gulf of California in the Pliocene and documents a geographic extension of Woodring's Tertiary province. *Nodipecten* from eastern Panama are phylogenetically closer to those from northwestern Mexico than to those across the isthmus. Detailed distributions of other cognates need to be determined and the faunal ranges compared with tectonic plate boundaries for possible correlations. Preliminary work indicates important data can be expected from cognate species of the arcids, pectinids, crassatellids, cardiids, venerids, eurytellinids, semelids, trochids, architectonicids, strombids naticids, cassids, cypraeids, cymatids, muricids, vasisds, columbellids, and marginellids. West American fossil localities where *Caribiphiles* occur may yield other cognates. These areas include the Imperial Valley of California, the Santa Rosalia area (Pliocene Inferno and Gloria Formations), eastern Cabo San Lucas, and the Tres Marias Islands.

CURRENT THOUGHTS ON THE SYSTEMATIC STATUS OF MEMBERS OF THE BIVALVE GENUS *Mytilopsis* CONRAD, 1857

Dan C. Marelli

Ecological Analysts, Inc.
2150 John Glenn Drive
Concord, California 94520

Mytilopsis is one of two extant genera in the family Dreissenidae, a group of fresh and brackish water epifaunal bivalves. *Mytilopsis* is predominantly tropical and warm temperate in its distribution, and all members of the genus are coastal inhabitants.

Although not well studied, over twenty-one recent species of *Mytilopsis* have been described, of which nine have been generally accepted. Of these nine, one species is west African, another is northwestern European, and a third is found in Fiji and eastern India. The remaining six species are Central and South American forms, with one ranging to the Hudson River estuary of eastern North America.

Based on recent observations of dried material from a number of sources, I tentatively propose the following synonymies: *Mytilopsis adamsi* Morrison, 1946 = *M. allyneana* Hertlein and Hanna, 1949 and *M. zeteki* Hertlein and Hanna, 1949; *M. leucophaeta* (Conrad, 1831) = *M. cochleata* (Kickx, 1835); *M. sallei* (Recluz, 1849) = *M. domingensis* (Recluz, 1852). I have not proposed that *M. trautwineana* (Tryon, 1866) or *M. africana* (Van Beneden, 1831) be held in synonymy with any of the above species, although they appear to have affinities with each other and with *M. sallei*.

THE ALEUTIAN ISLANDS AS A ROUTE FOR LAND MOLLUSK DISPERSAL

Barry Roth

California Academy of Sciences
Golden Gate Park
San Francisco, California 94118

Seven species of land mollusk (2 slugs, 5 snails) were collected on Attu, westernmost Aleutian Island, in July 1979. Three are circumboreal species, two are amphi-Arctic (Palearctic and Nearctic but not circumboreal), and two are Nearctic. Barring the unlikely survival of mollusks in local refugia, the fauna was assembled overwater since deglaciation—perhaps within the last 10,000 years. Mollusk faunas from Kamchatka to southeastern Alaska all have a Holarctic component of between 38 and 86 per cent, highest in those faunas showing least overall diversity. A Palearctic component present on Kamchatka and the Commander Islands is absent from the Aleutians, which have a Nearctic component that diminishes westward. The strait between Attu and the Commander Islands seems to form a barrier for snails and slugs as it evidently does in part for carabid beetles and other ground-dwelling insects. Future

study of the relationships of a slug (*Prophysaon*) from Attu may establish whether a similar barrier exists between the eastern Aleutians and mainland Alaska. *Prophysaon* is part of a group of maritime, low-elevation, northeast Pacific rim species absent from northern Alaska. The Bering land bridge may have been unavailable to it while for hardier, high-Arctic forms a freer faunal interchange was possible. The Aleutian mollusk fauna is most readily interpreted as part of the Nearctic fauna and shows no evidence that the Aleutian arc has been a route for Asian-American dispersal.

ZOOGEOGRAPHY OF THE MOLLUSKAN FAMILY ONCHIDIIDAE (GASTROPODA: PULMONATA) IN THE PACIFIC BASIN

John K. Allen

Department of Zoology
University of California
Berkeley, California 94720

Distribution patterns of the marine pulmonate gastropod family Onchidiidae are best explained by past continental configurations and subsequent drift rather than by theories of larval dispersal, rafting, or similar chance events. Unlike most marine organisms, members of the Onchidiidae lack planktonic dispersal stages in their life cycle, thus eliminating a distributional factor which tends to cloud the relationship of geographical distribution of organisms to past continental configurations. Pacific Basin biogeographical relationships, unlike amphi-Atlantic and Gondwanan distributional patterns, have not until recently been analyzable in terms of past continental configurations. Recent data given by geologists indicate that elements of Western North America may have originated far to the south and east of their present positions, and subsequently collided with the North American craton. The distribution of the Onchidiidae and especially of the genus *Onchidella* corroborates the geologists' findings and suggests extensions (albeit speculative ones) to their results, such as the presence of a land mass situated north of Antarctica, which subsequently broke up and whose continental fragments collided with parts of Western North and South America, the Caribbean, and Asia.

DISTRIBUTIONAL PATTERNS IN THE NEARSHORE BIVALVE MOLLUSCS OF THE WESTERN BEAUFORT SEA (ALASKAN ARCTIC)

Andrew G. Carey, Jr., and Paul H. Scott

School of Oceanography
Oregon State University
Corvallis, Oregon 97331

Bivalve molluscs from the nearshore waters (5-25 cm) of the western Beaufort Sea were quantitatively sampled with a Smith/McIntyre grab. Seventeen station sites spanned the region from Point Barrow to Barter Island, Alaska. Thirty-one living bivalve species were identified with *Axinopsis*

orbiculata (G. Sars 1878), *Portlandia arctica* (Gray 1824), *Liocyma fluctuosa* (Gould 1841) and *Macoma calcareo* (Gmelin 1791) being the numerically dominant species. Possible factors affecting the bivalve distribution include ice gouging of the sediment surface and sediment distribution. Deposit feeders comprise a higher percent of the bivalve numbers in the organic rich clays seaward of the 15 to 20 meter depth contours. Although numbers are low in the inshore sandy regions (5-10 meters) filter feeders dominate the area. Over 85% of the species present have large yolky eggs which possibly indicates a short or absent planktonic larval stage and extended lecithotrophic development.

Eocene MOLLUSK ASSEMBLAGES FOR A DELTAIC ENVIRONMENT

Elizabeth A. Nesbitt

Department of Paleontology
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Late Eocene strata of the Cowlitz Formation, southwestern Washington, contain six recurrent mollusk associations. The fauna is subtropical and reflects fresh water, estuarine and shallow and deep water marine facies. Although there are few genera in common, the paleoecological units are comparable with Recent macro-invertebrate assemblages from the Mississippi Delta. The trophic structure and the associated substrates of each assemblage are distinctive. Plotted on feeding habit-substrate niche ternary diagrams (Scott, 1976) they separate out. At the familial level the Eocene assemblages are functionally identical to the Recent subtropical deltaic communities in terms of feeding modes and inferred relationships.

PLEISTOCENE MARINE INVERTEBRATES FROM THE MENDOCINO COAST, NORTHERN CALIFORNIA

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Fossil invertebrate faunas of 62 and 40 species from Point Arena and MacKerricher State Park near Fort Bragg, respectively, correlate with the middle to late, cool-water phase of marine oxygen isotope stage 5 (80-105,000 years BP). The Point Arena fauna consists of 14 bivalves, 27 gastropods, 6 bryozoans, 4 barnacles and 14 (+) misc. taxa (including 3 fish). Bivalves are mostly infaunal rock-borers or nestlers, or live in rocky areas; most of the gastropods and nonmollusks occur on rocky surfaces or on intertidal to subtidal reefs. Bathymetric ranges indicate mainly deeper adlittoral, or more likely, shallow inner sublittoral depths (9 to 18-27 m). The limpets are dominated by sublittoral rather than littoral species. Eight taxa are extralittoral northern ones and suggest a latitudinal temperature regime equivalent to the modern Columbian subprovince (Puget Sound to Dixon Entrance).

The MacKerricher State Park fauna, which consists of 10

bivalves, 18 gastropods and 14 (+) misc. taxa (including 2 fish), was delivered mainly from middle to upper intertidal regions on a rocky coast. The dominant mollusks here are *Littorina sitkana* Philippi, 1946, and *Siphonaria thersites* Carpenter, 1864. Four extralimital northern species suggest a Columbian subprovincial aspect to the fauna, although a small Aleutian element is also present.

THE REPRODUCTIVE BIOLOGY AND SPAWNING CYCLE OF *Calliostoma*

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The reproduction of 4 species of *Calliostoma* Swainson, 1840 was investigated for 18 months at Point Cabrillo, Pacific Grove, California. Observations of the reproductive morphology show all females have an anteriorly located thickened portion of the reno-pericardial duct (urino-genital papilla). This glandular lobe secretes mucous in which eggs are deposited. Motile sperm also becomes embedded in this mucous during spawning. Free-spawning is the most common spawning behavior. However, spawning pairs (sperm drawn into the females' inhalant water stream with fertilized eggs extruded 1-6 hours later or sperm directed toward extruded egg ribbons) and lone females laying fertilized eggs have been observed. Larval development is direct. Unlike the European species of *Calliostoma*, these larvae hatch and go through a brief planktonic stage. Spawning cycles based on monthly gonad indices and histological examinations are synchronous for both *C. annulatum* (Lightfoot, 1786) and *C. canaliculatum* (Lightfoot, 1786). Gonad levels are high during the summer and winter and low during the spring and fall. *Calliostoma ligatum* (Gould, 1849) shows a regular pattern of spawning throughout the year. Possible mechanisms operating to produce the observed reproductive strategies were discussed.

MUSSELS FROM THE GALAPAGOS RIFT

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In February and November 1979 a team of biologists examined the Galapagos Rift hydrothermal vents, conducting experiments, collecting samples, and photographing the remarkable animals found at 2500 m. The shell morphology and anatomy of mussels from this site are described and compared with other members of the family Mytilidae.

FILTER-FEEDING ASPIDOBANCH LIMPETS FROM SUBMARINE THERMAL SPRINGS OF THE GALAPAGOS RIFT

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A new limpet species, representing a new genus and family living near vents of thermal springs on the Galapagos Rift feeds on chemosynthetic sulphur bacteria. Shell and animal resemble the mesogastropod family Calyptraeidae, having long gill filaments and a food groove leading to the mouth. However, it has archaeogastropod characters such as rhypidoglossate radula, epipodial tentacles, primitive nervous system, gonad discharging through the right kidney, and a bipectinate gill. The single gill lacks dorsal afferent attachment and leads to a monotocardian heart. The convergent Calyptraeidae differ in having a taenioglossate radula, crystalline style, more advanced reproductive system and monopectinate gill with dorsal attachment. Anatomical characters suggest that the closest living relatives are archaeogastropods with paired gills. Although fossil predecessors are not known, similar anatomy could have been present in some extinct archaeogastropod families.

FOSSIL *Xenophora* FROM BAJA AND ALTA CALIFORNIA

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Two Cretaceous fossil *Xenophora* were found along the Pacific coast of Baja California. Neither have been described by an authority. At Salsipuedes, 60 miles south of San Diego, in the Rosario Formation, a well-preserved fossil *Xenophora* was collected. The shell is in the collection of George Lee, Jr., of Costa Mesa. At Santa Catarina Landing, 200 miles south of San Diego, a second fossil *Xenophora*, also from the Rosario Formation was collected. This specimen is in the Los Angeles County Museum of Natural History, Geology Department. Six fossil *Xenophora* have been found in Alta, California. The *X. simiensis* Nelson, Martinez Formation, Eocene, Ventura Co., *X. hawleyi* Loel and Corey, Vaqueros horizon, Lower Miocene, Santa Barbara Co., *X. stocki* Dickerson, Tejon Formation, Eocene, San Diego Co., *X. zitteli* Weaver, Martinez Formation, Eocene, has been collected at San Angel, Baja California. Two fossil *Xenophora* sp. nov. Eocene, were collected, one from Kings Co., the other from Contra Costa Co. The holotype of *X. simiensis* is in the California Academy of Sciences, San Francisco, the others in the University of California collection of Invertebrates Paleontology, Berkeley.

IS THERE A COILED ANCESTOR IN THE DOCOGLOSSAN PHYLOGENY?

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Russian workers have proposed that the docoglossan limpets are descended from ancestors with patelliform shells and that the asymmetry of the docoglossan pallial complex is an adaptation to conditions not associated with the problem of water regulation and the turbospiral shell. However, there is evidence for a turbospiral ancestor and it is present in the docoglossan larva and in the orientation of the docoglossan protoconch on the teleoconch.

Docoglossan larvae have opercula. Recent docoglossans have no use for this structure. Consequently, is the operculum of the larval stage a vestigial structure that was once retained in an ancestor or is it an adaptation to benefit the larva?

The operculum is thought to have two functions (1) protection against desiccation, and (2) protection against predation. Selection for a structure to prevent desiccation in a pelagic organism or during the planktonic phase of the life cycle is unlikely. Also, it is unlikely that the operculum is a larval modification to prevent predation because (1) predators on larval forms are generally several orders of magnitude larger than their prey and they would not be hampered by the presence of an operculum, (2) the operculum appears halfway through the larval stage and is only present just before settling, and (3) acmaeid larvae cannot fully withdraw into the protoconch and without full withdrawal the operculum is useless as a defense against predation.

I propose that the presence of the operculum in the ontogeny of docoglossan limpets indicates a nonlimpet-like ancestor and that the docoglossan shell is secondarily flattened.

Was the ancestral shell turbospiral or planospiral? In the docoglossans the protoconch is offset as much as 20° to the right of the anterior-posterior axis of the teleoconch. In secondarily flattened nondocoglossan genera such as *Hippomix*, *Capulus* and *Crepidula* the protoconch is offset to the left and if the early coiling is continued a turbospiral, dextral shell results. In comparison, if the docoglossan coiling is continued the right offset would yield a turbospiral, sinistral shell.

The Russian scheme requires that torsion and the asymmetry of the pallial complex arise in two distinct lineages. In both lineages these adaptations would have to be identical solutions to problems associated with both turbospiral shells and patelliform shells. I consider the asymmetry of the docoglossan pallial complex to be associated with the problems of water regulation incurred by a turbospiral ancestor. Based on the offset of the protoconch in relation to the teleoconch the ancestor would have had a sinistral shell. However, the dextral anatomy of Recent docoglossans and the counter-clockwise coiling of the larval operculum indicates that the ancestor would have to be hyperstrophic.

PROTOCONCH CHARACTERISTICS AS INDICATORS OF RELATIONSHIPS IN THE CYPRAEIDAE

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Existing systematic arrangements for the true cowries of the mesogastropod genus *Cypraea* Linnaeus, 1758 (*s.l.*) have never been verified as indicators of evolutionary relationships between species. As part of a biogeographic analysis of this family, I quantified the pioneering results of Ranson (1967), who made qualitative judgments about interspecific relationships of the majority of *Cypraea* species. Using two parameters specified by D'Arcy Thompson (1961) to measure coiling and expansion of the protoconch, a number of groups of species may be identified.

Comparisons of these results to the systematic arrangement of Schilder and Schilder (1971) and the suggestions of Kay (1960) show that many of the groups which are separable using the protoconch are the same as those erected using adult shell characteristics or soft part anatomy. In particular, the species of the subfamily Bernayinae Schilder, 1927, subfamily Cypraeinae Gray, 1824, and the tribe Cypraeovulinii Schilder 1927 are maintained as separable clusters of species, as Schilder and Schilder placed them.

Difficulties arise for the subfamily Erroneinae Schilder 1927, whose species fall within 3 distinct groups of the protoconch results. Analysis of the differences between protoconch results and Schilder-Schilder adult taxonomy show the most disagreement about the cypraeovulinids, the tribe Zonariini Schilder, 1932 of the Atlantic, Mediterranean, and Eastern Pacific, and the small Indo-Pacific cowries in *Notadusta* Schilder, 1935, *Palmadusta* Iredale, 1930, and *Cribrarula* Strand, 1929. Differences with Kay's system arise in her R1 radula group, which I argue stem from polyphyletic origination.

I suggest that protoconchs promise to be more reliable indicators of relationships than adult shell characteristics, despite Dall's (1924) objections to their use. Expanded use of juvenile shell characteristics, combined with greater exploration of soft part anatomy, may provide a reliable systematic arrangement.

CHITON GIRDLE HAIRS: ULTRASTRUCTURE OF NEWLY DISCOVERED SENSORY ORGANS AND SPECULATIONS ON THEIR FUNCTIONS

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Chitinous hairs are formed by the integument of *Mopalia muscosa*. They form during the first week after metamorphosis. Adult hairs were examined by TEM and SEM and were found to be tubular with a groove on the mesial surface. They are secreted by epidermal papillae. The largest hairs are 0.3mm in diameter and 5.0mm in length. The wall or cortex is composed of two distinct layers. The medulla

contains a matrix of low density and up to two dozen longitudinally oriented bundles of dendrites. The dendrites are assumed to arise from primary receptor cells in the papillae. Sensory fibers have not previously been reported in chiton hairs. Juvenile hairs are produced by single cells and are initially all cortical material. Successive stages of hairs from developing juveniles are being studied to determine when the hairs become innervated, how many neurons are associated with each medullary bundle and where the neuron cell bodies lie. The hairs may be mechanoreceptors because the animals respond when the hairs are moved or pinched. The dendrites do not contact the environment so it is unlikely that the hairs are chemoreceptors. Both of these functions will be more thoroughly studied in a series of behavioral tests this summer (1980).

STUDYING RADULAR MORPHOLOGY

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The radula is considered a valuable taxonomic tool. This paper presents methods of radular extraction from the animal, preparation for microscopic examination, and technical illustration of the morphology of the teeth. Illustrations include representative material with scanning electron and light microscopy.

EVOLUTION AND FUNCTION OF ASYMMETRY IN THE ARCHAEOGASTROPOD RADULA

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Asymmetry has evolved numerous times in rhipidoglossate radulae of marine archaeogastropods. It is most prominently developed in the primitive Pleurotomariacea and Fissurellacea. Asymmetry in the Cocculinacea is "reversed" indicating an independent origin. Multiple origins and losses of asymmetry suggest a relatively simple genetic control. Within a family or genus the degree of asymmetry may vary considerably, involving two kinds of skewing of rows, and, in extreme cases, pronounced asymmetry of the rachidian tooth and non-reflectivity of lateral tooth pairs. Asymmetry is most pronounced in radulae that have also developed large, strongly-cusped outer lateral or inner marginal major food-preparing teeth. It functions primarily to allow efficient folding of the radula both during withdrawal at the close of the feeding stroke and for efficient storage when it is not in use. Asymmetry of use can occur even in the absence of physical asymmetry of the radula. Asymmetry of use is confirmed by asymmetrical feeding tracks. It is facilitated by the independent of the two horns of the odontophore, which can be manipulated independently to produce asynchrony of feeding.

FUNCTIONAL DYNAMICS OF THE RHIPIDOGLOSSAN RADULA OF *Tegula funebris*

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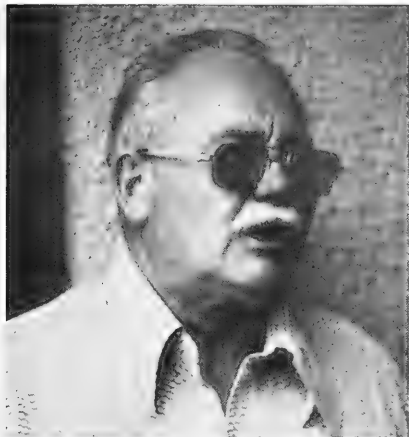
Unsuspected complex shape changes, tooth-substrate interactions, and inter-tooth interactions in the rhipidoglossan radula of the herbivorous intertidal trochid gastropod *Tegula funebris* (A. Adams) are revealed by a combination of slow-motion cinematography, optical microscopy, and scanning electron microscopy, paired with feeding track data from artificial and natural substrates. These data help generate a simple model clarifying tooth row movements and conformational changes in the radular membrane during feeding. In contradiction to the standard concept of radular function, marginal teeth are the main food-preparers and collectors rather than lateral and rachidian teeth. Marginal cusp differentiation, row curvature, and longitudinal displacement of rows, combined with posterior movement of the semicircularly-edged bending plane, efficiently divide the duties of gouging, scraping, and brushing among successive rows as they sweep over an area of substrate. Adjustments in odontophoral pressure allow a wide range of feeding behavior from light brushing to heavy gouging of the substrate. The data require reevaluation of assumptions about the mechanical simplicity of radulae and implications for inferring degrees of feeding specialization in primitive gastropods in the fossil record. Detailed comparative radular studies of rhipidoglossan species representing other major feeding modes and dietary specializations are encouraged.

IN MEMORIAM: ROBERT R. TALMADGE (1913–1979)

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Robert R. Talmadge, June 1974

(Photograph by James H. McLean)

Robert R. Talmadge, one of Northern California's best known naturalists passed away in November of 1979, after a series of debilitating strokes. The first stroke had occurred in May 1978 while he was on a collecting trip to Shelter Cove. He was camping by himself and had to strike his tent and drive home without the use of his left arm. This kind of tenacity was typical in the life of this self-taught malacologist whose knowledge of the world's abalones (*Haliotis*), Northern California land snails, and deep water Gastropods (*Neptunaea*) was extensive. Bob's knowledge of the geologic history and fauna of Northern California impressed all who met him. His enthusiasm for his field of study was infectious and was revealed when he traveled with College of the Redwoods classes on biology field trips. Birds were his first natural history interest, and he would dazzle students by sometimes being able to identify birds from a single tail feather. Bob abhorred common names and exercised his command of the scientific names of birds and mollusks, often down to subspecies. His consistent use of scientific terminology was often interpreted as "talking over the heads" of people who were not hardcore biologists. However, the exposure to Bob's disciplined use of terminology was a lesson in itself since Bob was always thinking, planning, and doing scientific inquiries at work, at home and on vacation.

Born in Selma, California in 1913, his early years were spent in Southern California. He attended elementary school in San Bernardino and his family moved to Eureka where he attended junior high school. It is always hard to pinpoint the events in childhood that lead one toward the study of natural history. We do know that he brought a dead skunk to his 7th grade class and was promptly directed

to throw it in the bushes behind the school. He later skinned the skunk and kept it until it was lost in a fire in 1960 which gutted his house in Willow Creek and destroyed most of his collection. Bob was a student at Eureka High School where he graduated in 1933. With the exception of a few junior college and extension courses, Bob ended his formal education when he received his high school diploma.

In 1934 he delivered a road kill white-tailed kite (*Elanus leucurus*) to the California Academy of Sciences in San Francisco. This contact with the academy led to his proudest achievement: becoming a field associate for the Academy in the 1950's. He began to publish ornithology articles in the *Condor* and *Auk* in the late 1930's. In the 1940's Bob married, and he served with an armored reconnaissance unit in Europe. After World War II he went to work as a lineman for the Pacific Gas and Electric Company. He moved to Willow Creek in 1949. In the 1950's his attention shifted to molluscan distribution and taxonomic problems. In September of 1956 *LIFE* magazine published a picture of Bob standing hip deep in a Trinidad tide pool. *LIFE* magazine listed him as one of the world's great amateur scientists. The magazine noted that he was "a self taught expert on abalones of the world." He had by this time gained a workable knowledge of French, German and Russian and used these languages in his literature searches and correspondence.

In 1975 Bob retired from the Pacific Gas and Electric Company and began to travel. He visited Europe, Russia and Japan in connection with his work on deep water fauna brought in by Humboldt Bay drag boat captains. At this time he was appointed Curator of the Natural History Collections of College of the Redwoods in Eureka.

Bob's membership in scientific societies was extensive. He published in many journals and made presentations at numerous scientific meetings. It is the feeling of these writers that his contributions to scientific literature have been substantial and his influence on the many students who have met him has been beneficial. Bob Talmadge's life is a fine example of how one can profitably invest a sizable portion of one's time in observing, exploring, collecting and recording the fascinating things that surround us in nature.

His farewell service was conducted on the beach at Trinidad (Humboldt County) by his son, Robert C. Talmadge, on December 1, 1979. At the conclusion of the ceremony, his son faced the sea and delivered three deep blasts from a huge Australian trumpet shell. In remembrance of Bob, each guest received a *Neptunaea pribiloffensis* (Dall, 1919). Following the ceremony the ashes of Robert R. Talmadge were spread on the Pacific Ocean.

Mr. Talmadge is survived by his wife, Esther, a son, Robert C., a daughter, Nancy Motian, and four grandchildren.

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IN MEMORIAM: EMERY P. CHACE (1882-1980)

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Emery P. Chace, 23 June 1975

(Photograph by James H. McLean)

Emery Chace was born in Rhode Island on July 31, 1882. At the time of his death, May 19, 1980, he was in his 98th year. He finished high school and had some college training in Rhode Island, then moved with his parents to California in 1901. In 1905 he married Elsie Herbst and found work as an electrician in the Los Angeles area. The Chaces, on their street-car excursions around the region, discovered the sea-shore by 1910. They became fascinated with marine life, although they had little guidance in its study until Elsie was invited, in 1913, to join a study group that later became the Conchological Club of Southern California. This comprised a dozen women who met to help each other with their collections. It was a closed club of twelve members. However, it yielded to pressure when the Southwest Museum offered a meeting place provided they would open the rolls to outsiders and would include men. The first three men to join were Emery Chace, Allyn Smith, and William Golisch.

Thus started for the Chaces the life-long enchantment of collecting mollusks—fifty years of it. From the start they kept careful notes on where they went and what they saw and brought back. In 1967, knowing that these notes would

be of more than passing value to others, they published a summary of their notebooks, with the assistance of the San Diego Society of Natural History. The notebook account ends with the year 1963.

All of this meticulous collecting of data and specimens was financed from the Chaces' own resources, for museum support did not come until late in their lives. During the Depression years, when work was scarce, they took whatever jobs were offered, but always they managed to collect. For example, when caretaking motels in the mountains, they searched for land snails, and in the construction work Emery did, he salvaged many Pleistocene fossils from localities that now are paved over. The Chaces were especially considerate in helping beginners. I well remember how, in 1934, they were the first experienced collectors to give me advice. After Emery had reached retirement age, he and Elsie were invited by the San Diego Society of Natural History to become curators of the Society's shell collection, and they worked actively there for several years, until Elsie was invalidated by arthritis.

Few people are able to sustain for so long the unflagging interest that Emery and his team-mate Elsie had. I am proud to remember that we chose them in 1960 as first recipients of the Award of Honor of the Pacific Division of the American Malacologists Union. The AMU's report for that year pictures the certificate, and I cannot better the words of the citation: "... in recognition of their long and fruitful devotion to conchology, their kindly interest in younger students, and their unfailing generosity to all." Around the borders of the certificate are figures of nine species of mollusks that were, over the years, named in the Chaces' honor.

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TAXA DESCRIBED BY EMERY P. CHACE

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Nassarius howardae Chace, 1958

Monadenia fidelis beryllica Chace & Chace, 1935

IN MEMORIAM: JOSHUA L. BAILY, JR. (1889-1981)

Hans Bertsch
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Dr. Joshua Longstreth Baily, Jr., died at Mercy Hospital in San Diego, 18 April 1981. He was 92 years of age. His career included work as an historian, musicologist, composer, scientist, chess master, and philanthropist.

He was born 29 January 1889 in Philadelphia, Pennsylvania. He was graduated with a degree in literature from Haverford College, Pa., in 1912, a member of Phi Beta Kappa. The following year he finished a master's degree in music at the University of Pennsylvania. He composed three symphonies and continued to play his concert grand piano throughout most of his life.

His first trip to La Jolla was on a family vacation in 1902. As a young man he moved to the San Diego area, establishing homes in Mission Hills (which he designed himself) and La Jolla.

He met Ruth Ingersoll Robinson in La Jolla and they were married in 1917. They remained married for 48 years, until she died in 1965. They had no children.

Joshua Baily received his doctorate of science degree from Johns Hopkins University in 1938. He published over 60 articles primarily on western United States land snails, California marine mollusks, and nomenclatural usage. Most of his papers, spanning nearly 70 years, appeared in *The Nautilus* and *The Bulletin of Zoological Nomenclature*.

He named two molluscan genera (*Iolina* and *Maxwellia*) and coauthored with his wife the naming of 4 specific molluscan taxa.

He was a past president of the San Diego Historical Society and the American Malacological Union, and a life member of the San Diego Natural History Society and the Zoological Society of San Diego. He held memberships in the Maritime Museum Association of San Diego (which included being an honorary mate of the *Star of India*), the Railway and Locomotive Historical Society, the National Association for the Advancement of Colored People, San Diego Museum of Art, and the San Diego Humane Society. His personal shell collection was donated to the San Diego Natural History Museum. The major part of the collection of the Department of Marine Invertebrates at SDNHM is composed of the gifts of Herbert N. Lowe and Joshua L. Baily, Jr.

The cremated remains of Dr. Baily were mixed with those of his wife. They were buried in Springdale Cemetery, near his wife's hometown of Peoria, Illinois.

Obituaries of Dr. Baily have appeared in the *San Diego Evening Tribune* (21 April 1981) and *The Festivus* (May 1981). Publication schedules have prevented the inclusion of a bibliography of Joshua L. Baily, Jr., but a fairly complete listing can be found in *The Festivus* 13 (5): 63-65.

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Malacology
Hyakunin-cho
Shinjuku-ku
Tokyo 160 Japan

**Natural History Museum
of Los Angeles County**
900 Exposition Boulevard
Los Angeles, CA 90007

Naturhistorisches Museum
Rutjmeyer—Bibliothek
Augustinerstrasse 2
CH-4051 Basel, Switzerland

Naturhistorisches Museum, Wien
3 Zoologische Abteilung
Postfach 417 Burggasse 7
A-1014 Wien, Austria

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Altadena, CA 91001

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1600 Holloway Avenue
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Postbox 20125
Amsterdam 1000HC
Netherlands

New Zealand Geological Survey
Librarian, Central Library
DSIR, P.O. Box 30368
Lower Hutt, New Zealand

New Zealand Oceanographic Institute
The Librarian
P.O. Box 12-346
Wellington, New Zealand

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Loleta, CA 95551

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121 Wild Horse Valley Drive
Novato, CA 94947

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Moss Landing Marine Laboratories
P.O. Box 223
Moss Landing, CA 95039

Of Sea and Shore, Inc.
P.O. Box 219
Port Gamble, WA 98364

Ohio State Museum
The Librarian
1813 No. High Street
Columbus, OH 43210

Old, Mr. William E., Jr.
Dept. of Living & Fossil Inverts.
American Museum of Natural History
79th Street at Central Park West
New York, NY 10024

Pacific Biological Station
Fisheries Canada
Nanaimo, B.C.
Canada V9R 5K6

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San Diego, CA 92105

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The Librarian
1259 Trumansburg Road
Ithaca, NY 14850

Ramsaran, Mrs. Jo
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San Bernardino, CA 92404

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126 B Street
Redwood City, CA 94063

Rice, Mr. Thomas C.
Of Sea and Shore Magazine
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Port Gamble, WA 98364

Rijksmuseum van Natuurlijke Historie
Afdeling Systematische Dierkunde
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Leiden, The Netherlands

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Box 379
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Smithsonian Institution
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San Diego Society of Natural History
Library
Balboa Park
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2559 Puesta del Sol Road
Santa Barbara, CA 93105

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10 Porchester Garden
London W2 4DE England

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University of California
General Library (Serials)
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University of California at Los Angeles
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Los Angeles, CA 90024

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Serials
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University of CA, San Diego
La Jolla, CA 92093

University College
The Library
Galway, Ireland

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2550 The Mall
Honolulu, HI 96822

University of Kentucky Libraries
Acquisitions Department
Central Serials Record
Lexington, KY 40506

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The Museum
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England

University of Miami
RSMAS Library
4600 Rickenbacker Causeway
Miami, FL 33149

University of Washington
The Library
Acquisitions Division, Book Orders
Seattle, WA 98105

University of West Florida
Library Serials
Pensacola, FL 32504

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Box 2228
Sierra Vista, AZ 85635

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THE WESTERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT



San Diego, California
23-26 June 1981

Volume 14

THE WESTERN SOCIETY OF MALACOLOGISTS

Annual Report

Volume 14

San Diego, California

23-26 June 1981

Issued:

JUL 13 1982

Editorial Board, 1981-1982

Mr. Michael G. Kellogg, *Editor*
Dr. Barry Roth
Dr. Eugene Coan
Mrs. Linda Lee Kellogg

The **Annual Report** of the Western Society of Malacologists is based on its yearly meeting. Distribution of the **Annual Report** is free to regular and student members who are, at the time of issue, in good standing. Membership dues are \$7.50 and \$3.00 for students. Others of a regular member's family may join for an additional \$1.00; each family receives only one **Annual Report**.

The Western Society of Malacologists has issued two **Occasional Papers** — No. 1, "Sea Shells of Tropical West America: Additions and Corrections to 1975" by Myra Keen & Eugene Coan; and No. 2, "A Catalogue of Collations of Works of Malacological Importance" by George E. Radwin & Eugene Coan. Each was priced at \$2.50. At this moment, the first is out of print. The second is still available.

Correspondence regarding membership and orders for additional or back issues of the **Annual Report** or the **Occasional Papers** should be addressed to the current W.S.M. Treasurer, Mrs. Margaret Mulliner, 5283 Vickie Drive, San Diego, CA 92109.

When longer papers are included in the **Annual Report** or the **Occasional Papers** they are reviewed by two members of the Editorial Board in addition to the Editor.

NOTICE OF THE 15th ANNUAL MEETING OF THE WESTERN SOCIETY OF MALACOLOGISTS

The 1982 meeting of the Western Society of Malacologists will be held 20-23 June 1982 at the University of Redlands, Redlands, CA. The program will include symposia on Bivalvia and on tropical west American mollusks, and contributed papers. In addition there will be exhibits, the annual shell auction, and the annual banquet. For further information, please contact WSM Secretary: Mrs. Katharine Stewart, 19 La Ranchera, Carmel Valley, CA 93924. Advanced registration is strongly encouraged.

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WESTERN SHELL CLUBS

Chico Seashell Club

c/o Phyllis Slattery, SEC.
106 Terrace Drive
Chico, CA. 95926
[meets twice a month, 2nd Wed 9:30 am in members' homes, and 4th Wed 7:30 pm at Pleasant Valley Recreation Center, North Avenue, Chico, CA]

Pacific Northwest Shell Club

c/o Mrs. Wilma G. Young, Corresponding Secretary
P.O. Box 1931
Seattle, WA 98111
[meets third Sunday of each month, 2:00 p.m., Lake City Christian Church, 1933 NE 125th Street, Seattle]

Conchological Club of Southern California

c/o Malacology Section
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, CA 90007
[meets in Museum Lounge, 7:30 p.m., first Monday of every month, unless a holiday, then on Wednesday of same week]

Pacific Shell Club

c/o Malacology Section
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, CA 90007
[meets in Museum Lounge first Sunday of each month, 1:30 p.m., October through June]

Hawaiian Malacological Society

P.O. Box 10391
Honolulu, HI 96816
[meets first Wednesday of each month, 7:30 p.m., at First United Methodist Church, Victoria & Beretania Streets, Honolulu; December party at another location]

San Diego Shell Club

c/o 3883 Mt. Blackburn Avenue
San Diego, CA 92111
[meets third Thursday of every month, Casa del Prado, Balboa Park]

Houston Conchology Society

c/o Constance Boone
3706 Rice Boulevard
Houston, TX 77005
[meets fourth Wednesdays of August, September, October, January, February, March, April, and May; third Wednesday of November, at the Houston Museum of Natural Science]

Santa Barbara Malacological Society

P.O. Box 30191
Santa Barbara, CA 93105
[meets third Friday of every month, 7:30 p.m., Santa Barbara Museum of Natural History, 2559 Puesta del Sol]

Northern California Malacozoological Club

P.O. Box 1249
El Cerrito, CA 94350
[meets third Thursday of each month, alternating between California Academy of Sciences and El Cerrito Fairmont Recreation Center]

Southwestern Malacological Society

c/o Mrs. Carol C. Skoglund
3846 E Highland Avenue
Phoenix, AZ 85015
[meets third Wednesdays, September through May, 7:30 p.m., Asbury United Methodist Church, 1601 West Indian School Road, in auxiliary rooms]

Oregon Society of Chonchologists

Dr. Byron W. Travis
4324 NE 47th Avenue
Portland, OR 97218
[meets first Sunday of each month, 1:30 p.m., in private homes; announcements given in monthly paper or by card]

Yucaipa Shell Club

c/o Mousley Museum of Natural History
35308 Panorama Drive
Yucaipa, CA 92399
[meets third Sunday of every month except August, 2:00 p.m., in the Museum]

MINUTES, EXECUTIVE BOARD WESTERN SOCIETY OF MALACOLOGISTS

The meeting was called to order by President Mrs. Carol Skoglund. Present were Dr. Donald R. Shasky, Mr. David R. Lindberg, Mr. Bruce H. Fowler, Mrs. Kay Webb, Mr. Ernest Haigh, Dr. Vida Kenk, Dr. Barry Roth, and Mr. Michael Kellogg.

The minutes of the 1980 Executive Board meeting were approved as printed in the Annual Report. The Treasurer's report was read by Mrs. Kay Webb. A motion to accept the report as read was made by Dr. Donald Shasky and seconded by Mr. David Lindberg. The motion carried.

Various ways to increase membership were discussed. It was decided not to increase dues at this time. Dr. Vida Kenk proposed looking into non-profit organization postal rates as a means to reduce costs. Editor Mr. Michael Kellogg will investigate.

Dr. Vida Kenk read the nominating committee report which recommended the following slate of officers:

President	Dr. Donald R. Shasky
1st Vice President	Mr. David R. Lindberg
2nd Vice President	Dr. George L. Kennedy
Secretary	Mrs. Katherine Stewart
Treasurer	Mrs. Margaret Mulliner
Member-at-Large	Mrs. Carole Hertz
Member-at-Large	Mrs. Sandra M. Gardner

A motion to accept the slate as presented was made by Mr. Ernest Haigh and seconded by Mr. David Lindberg. The motion carried.

Dr. Vida Kenk reported on the student Grant Committee. The WSM \$500 award for 1981 is to Mr. Douglas Ernise for his work on four species of the chiton genus *Cyanoplax*. His proposal was chosen from eleven submitted to the committee for consideration.

The necessity of increasing the grant amount to keep up with inflation and attract a larger number of applicants was discussed. Mr. David Lindberg moved that the extra money be obtained from supplementary contributions solicited from members along with regular dues. This contributed money would be added to the budgeted amount (\$500) with the treasury contributing additional funds to round off members contributions to even \$100 increments. The motion was seconded by Mr. Ernest Haigh and carried.

Dr. Donald Shasky proposed that the fifteenth annual meeting be held at the University of Redlands, Redlands, CA, June 20 through June 23, 1982.

Dr. Barry Roth moved to authorize Editor Mr. Michael Kellogg to have 200 copies of the Annual Report typeset and printed at an estimated cost of \$1200.

A congratulatory note to the American Malacological Union on the occasion of their 50th anniversary was proposed by Dr. Donald Shasky.

A card for Dr. Myra Keen will be circulated at the banquet for all to sign.

As there was no further business, the meeting was adjourned.

MINUTES, ANNUAL BUSINESS MEETING WESTERN SOCIETY OF MALACOLOGISTS

The meeting was called to order by President Mrs. Carol Skoglund.

The minutes of the 1980 Annual Business Meeting and the 1981 Executive Board Meeting were read and approved.

The Treasurer's report was presented by Mrs. Kay Webb, who reported a current balance of \$4,252.88. A motion to accept the Treasurer's report was made by Mrs. Twila Bratcher and seconded by Mrs. Helen DuShane. The report was accepted.

An additional income of \$798.80 from this year's auction was not included in the Treasurer's report. Mrs. Carol Skoglund thanked auctioneers Mr. Matt James and Mrs. Carole Hertz, and all those who helped in the successful fund raising event.

The nominating committee report was given by Dr. Vida Kenk, who recommended the following slate:

President	Dr. Donald R. Shasky
1st Vice President	Mr. David R. Lindberg
2nd Vice President	Dr. George L. Kennedy
Secretary	Mrs. Katherine Stewart
Treasurer	Mrs. Margaret Mulliner

Member-at-Large	Mrs. Carole Hertz
Member-at-Large	Mrs. Sandra M. Gardner

There were no nominations from the floor. Mrs. Helen DuShane moved that the slate be accepted as presented. Dr. Eugene Coan seconded the motion, and the officers were elected by unanimous vote.

Dr. Donald Shasky proposed the University of Redlands, Redlands, CA as the meeting site for the fifteenth annual meeting of the WSM on 20-23 June 1982. Dr. Vida Kenk moved that we accept the recommendation. The motion was seconded by Mrs. Twila Bratcher and was carried.

Dr. Vida Kenk announced the "get-well" card for Dr. Myra Keen would be available at the banquet for all who wish to sign.

Mrs. Carol Skoglund announced that the report of the student grant committee as well as turning the gavel over to the incoming president would take place at the banquet.

As there was no further business, the meeting was adjourned.

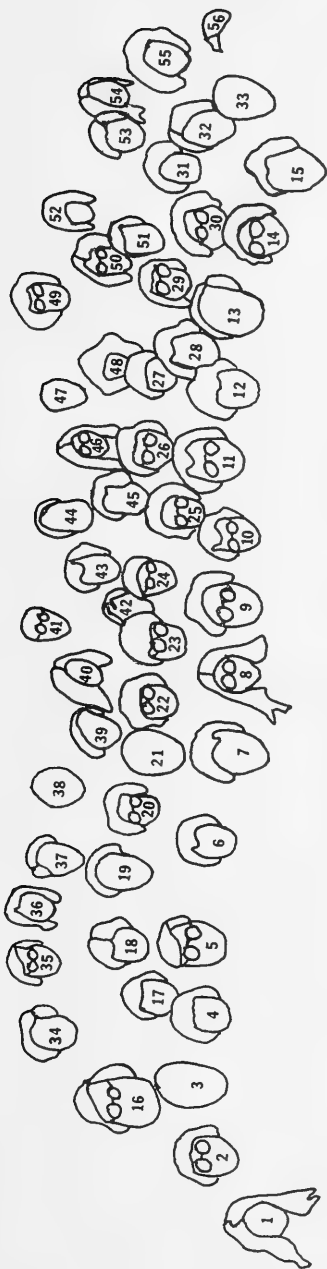
TREASURER'S REPORT

15 July 1980 through 5 July 1981

Balance as of 15 July 1980				\$2464.24
		INCOME		
Dues:				
1979 1 Regular	\$ 7.50			
1980 16 Regular	120.00			
2 Family	2.00			
3 Student	9.00			
1981 171 Regular	1282.50			
21 Family	21.00			
12 Student	36.00	\$1478.00		
Publications:				
Annual Reports				
2 @ \$2.50	5.00			
12 @ \$5.00	60.00			
4 @ \$7.50	30.00			
(postage)	.30			
Occasional Papers				
1 @ \$2.50	2.50	97.80		
Donations	1.50	1.50		
Savings Account Interest	90.18	90.18		
Convention Deposits	4261.50	4261.50		
Annual Shell Auction	798.80	798.80	\$6727.78	\$9192.02
		EXPENSES		
President's expenses	\$ 21.59	\$ 21.59		
Secretary's expenses	78.58	78.58		
Historian's expenses	29.10	29.10		
Transport display cases to 1980 meeting	60.00	60.00		
Mail historian book to LACM	3.79	3.79		
Filing fee non-profit organization	2.50	2.50		
AMU 1981 dues	13.00	13.00		
COA 1980,1981 dues	10.00	10.00		
1981 Convention Expenses:				
Deposits and fees to SDSU	3731.28			
Officer's expenses	140.63	3871.91		
Student Research Grant:				
Award	500.00			
Committee expenses	62.50	562.50		
Annual Report, Volume 13:				
Typeset	958.24			
Print	355.67			
Postage	71.17	1385.08	\$6037.60	\$6037.60
Balance at end of period				\$3154.42

Kay Webb, Treasurer





KEY TO GROUP PHOTOGRAPH

1. Janna Crane	20. Margaret Mulliner	39. James H. McLean
2. Tomoye Suematsu	21. William Dullas	40. Janice B. Sibley
3. David K. Mulliner	22. Mary Larson	41. Hugh Bradner
4. Edith Abbott	23. Norma Dullas	42. Pati Mastan
5. Bruce H. Fowler	24. Forrest Poorman	43. June King
6. Billee Mabry	25. Barbara Good	44. Ed Mastro
7. Kay Webb	26. Eva Schroeder	45. Helen DuShane
8. Tami Suematsu	27. Yvonne Albi	46. Sandra Millen
9. Carol C. Skoglund	28. Elsie Messing	47. Leroy Poorman
10. Kate St. Jean	29. Viola Perrault	48. Carey Resch Smith
11. Donald R. Shasky	30. Iva Barker	49. Peter Steinberg
12. Gladys Weber	31. Sandra M. Gardner	50. Paul Scott
13. David R. Lindberg	32. Daniel I. Iuarte	51. Ernest Haigh
14. Lucinda Draper	33. Bertram C. Draper	52. Sally Bennett
15. Vida C. Kenk	34. Steve Piper	53. Michael G. Kellogg
16. Patrick I. LaFollette	35. George L. Kennedy	54. unidentified
17. Twila L. Bratcher	36. Carole M. Hertz	55. Linda Lee Kellogg
18. Mark S. Eutenier	37. Matthew J. James	56. Joseph M. Kellogg
19. Eugene V. Coan	38. Barry Roth	

Others attending, but not in group photograph: Elmo Adams, Ann Adams, Hans Bertsch, Marge Bradner, Timothy Brand, Carol Burchard, Anthony D'Attilio, Tom Demere, Joyce Gemmel, Jules Herz, James Lance, Jerry Landye, Dixie Lindberg, Steve Long, William Minkel, Nola Michel, Barbara Myers, David Myers, Ron McPeak, Wally Robertson, Betty Roose, Pat Sage, Marty Schuler, John Steinbeck, Katherine Stewart, Ron Velarde, Jody Woolsey, and Teresa Zinser Peterson.

PAPERS PRESENTED TO THE FOURTEENTH ANNUAL MEETING: TITLES AND ABSTRACTS

A STUDY OF THE BIOLOGY AND ECOLOGY OF THE CHITON *Nuttallina californica*

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Several aspects of the biology and ecology of *Nuttallina californica* (Reeve 1847) inhabiting the intertidal reefs of Scott Creek, Santa Cruz Co., California, were studied from June 1978 to June 1979. Analyses included abundance, size class distribution, growth and mortality rates, periods of maximum reproductive activity as determined by a gonadal index, and sex ratio as a function of size. Densities decreased from 7.0-9.0/m² to 5.0/m² after periods of heavy storm activity. Chitons smaller than 16 mm were located primarily between the +.30 and +.90 m levels (relative to mean sea level) on reefs of *Phragmatopoma californica* (Fewkes 1889) colonies, and showed little decline in abundance. Larger individuals were most common in shale depressions among populations of *Mytilus californianus* Conrad 1837 at the +.90 to +1.2 m levels. These larger individuals accounted for most of the population decline. This species displayed a growth rate of 10 mm/year, and reached a maximum length of 60 mm at four years of age. *Nuttallina californica* appears to be reproductively active for most of the year with maximum gonadal indices occurring in late winter and early spring. Recruitment appeared to have occurred in April 1978 and again in September 1978. A 1:1 sex ratio was indicated for all size classes. Differential growth and hermaphroditism were not found. More studies of *N. californica* are required for better understanding of seasonal changes in growth, reproductive activity, abundance and distribution.

FACTORS AFFECTING FEEDING PREFERENCES IN *Tegula funebris*

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I investigated the feeding preferences of the herbivorous intertidal turban snail *Tegula funebris* (A. Adams 1855). Two main factors were examined: 1) Characteristics of *T. funebris* algal food, and; 2) the effect of a predatory seastar. Thirteen species of brown algae were examined in laboratory preference experiments. *Tegula funebris* preferred the six species that

were lowest (about 1% dry weight) in phenolic compounds and lacked tanning ability; the seven least preferred species were all high (4% dry weight or higher) in phenolics and tanning. Organic nitrogen content of the algae was positively correlated with *T. funebris* preferences. A partial correlation analysis showed, however, that this effect was more likely due to the fact that algae that were high in nitrogen were also low in phenolics, rather than nitrogen directly affecting feeding preferences. Thallus toughness of the algae, measured with a penetrometer, had no overall effect on *T. funebris* preferences, but may have been important in affecting choices between higher preference species. Experiments on the brown alga *Alaria marginata* Postels & Ruprecht 1840 show that *T. funebris* preferred the vegetative frond, which was low in phenolics, to the sporophylls, which were high. In the field vegetative blades are grazed significantly more. Results of other preference studies suggest that phenolic compounds in brown algae may be deterrents against many molluscan herbivores.

I also examined *Tegula* feeding behavior in the presence and absence of water which had flowed over the predatory seastar *Pisaster ochraceus* (Brandt 1835). In the presence of *Pisaster* "juice" *T. funebris* fed less, and generalized its feeding preferences. *Tegula brunnea* (Philippi 1848) also fed less in the presence of *Pisaster* "juice", but did not change its feeding preferences.

THE DESIGN AND USE OF AN EXPERIMENTAL POOL TO STUDY MOLLUSCAN BEHAVIOR

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An experimental concrete pool has been constructed which simulates major physical components of an intertidal zone. The pool includes an area with forceful water movement, an area with gently agitated water and a lightly sprayed cliff. The water level in the pool fluctuates twice daily and can closely follow local tidal rhythms. Forceful water movement is accomplished by circulating water through a pump which jets it back into certain areas of the pool at timed intervals.

The experimental pool is currently being used to study the feeding excursions and homing patterns of the owl limpet, *Lottia gigantea* Sowerby 1834. Their movements are monitored by the use of 8 mm time-lapse photography. The comprehensive movement records obtained of *L. gigantea* living in the pool have revealed an interesting homing pattern development. Film records of field work done on this limpet indicate that homing almost always occurs without the use of fresh outbound

trails. Movements recorded on the new substrates within the pool, however, show that fresh outbound trails are almost exclusively followed home during the first several weeks of new homesite development.

Since the pool is contained within a watertight framework it has also been easy to obtain close range film records of the movements of its inhabitants during high tides. This capability has been demonstrated in the construction of detailed pictorial records of the aggressive behavior of *Lottia gigantea* towards other limpets entering a defended feeding area.

A PRELIMINARY REPORT ON THE ROLE OF THE LIMPET *Lottia gigantea* IN LITTORAL COMMUNITY STRUCTURE

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[no abstract submitted]

IMPORTANCE OF GILL STRUCTURE IN TROCHACEAN CLASSIFICATION

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Although the single left ctenidium in the Trochacea is said to be monopectinate except for its anterior end (Fretter & Graham 1977:39), it is actually bipectinate for at least three fourths of its length. It appears to be monopectinate because the afferent membrane may conceal the shorter filaments on the left side of the ctenidial axis (see Fretter and Graham 1962, fig. 53).

Reported here is another condition in the Trochacea in which the afferent membrane is essentially absent except for a short portion posterior to the transverse pallial vein. The afferent axis of the ctenidium is exposed (visible in a mantle-cavity dissection) for more than three

fourths of its length between the free tip and the transverse pallial vein. A short afferent membrane is present posterior to the transverse pallial vein. Along this posterior portion of the ctenidial axis there are no ctenidial filaments on the left side. This condition has previously been noted only in *Margarites helacinus* (Fabricius) (Fretter 1955:161). I have found that it is also true of the liotiid *Macrarenia* and the trochid genera *Angaria*, *Bathybembix*, *Cidarina*, *Calliotropis*, *Euchelus*, *Turcica*, and *Tegula*. Except for *Angaria* and *Tegula*, the above-mentioned trochid genera have previously been placed in the subfamily Margaritinae.

I propose that this difference — presence or absence of an afferent membrane along the greater length of the ctenidium — be regarded as a major character in trochacean classification. Absence of this membrane is primitive, as it is a feature of the oldest trochaceans, the Liotiidae, which were shown by McLean (1981: 334) to date from the Permian. In the Trochidae the lack of the afferent membrane is characteristic of the two most primitive subfamilies, the Angariinae (cephalic lappets lacking) and the Margaritinae (cephalic lappets present).

Lineages within the Margaritinae can be recognized as tribes, defined on characters of the radula, shell, and epipodium: 1) Margaritini (only *Margarites* and subgenera); 2) Amberleyini (for genera related to *Bathybembix*, *Cidarina*, and *Calliotropis*, previously defined as a subfamily by McLean [1981:335]); 3) Chilodontini (genera related to *Euchelus*, *Danilia*, and *Turcica* — living members of a lineage previously thought limited to the Mesozoic); and, 4) Tegulini (*Tegula* and subgenera, previously thought related to such genera as *Monodonta* and *Gibbula*, in which the afferent membrane is well developed).

More detailed diagnoses will be given in a full review of the family and subfamily classification of the Trochacea now in preparation.

THE HALF MOON BAY TERRACE, SAN MATEO COUNTY, CALIFORNIA AND THE AGE OF ITS PLEISTOCENE INVERTEBRATE FAUNAS

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The Half Moon Bay terrace is a low, slightly undulating 0.1 to 2 km wide coastal plain that extends for 22 km, from Montara in the north to Tunitas Creek in the south. The terrace consists of a wave-cut platform overlain by littoral to sublittoral sands and alluvial deposits 6 to 20 m thick. The terrace has been deformed in its central region by compressional, synclinal warping (responsi-

ble for the present configuration of Half Moon Bay), and in the south, by gentle anticlinal warping. To the northwest the Seal Cove Fault has caused as much as 45 m of apparent vertical displacement of the terrace surface.

Marine fossils have not previously been known from the Half Moon Bay terrace, and its presumed age of $100,000 \pm 30,000$ years was based on limited geologic evidence and a possible correlation with emergent marine terraces to the south. Fossil invertebrate faunas, comprised mainly of mollusks, were recently recovered from two areas: 1) from southern Half Moon Bay approximately 0.57 km north of Miramontes Point (USGS loc. M7500); and 2) near Princeton, between the airport and the Seal Cove fault scarp (USGS locs. M7813, M7814). The fauna from the sea cliff exposure at loc. M7500 consists of at least 17 species of mollusks (10 bivalves, 6 gastropods, 1 chiton), 10 species of miscellaneous invertebrates, and 1 mammal. The fauna is dominated by the bivalve *Siliqua patula* (Dixon 1789) and the barnacle *Semibalanus cariosus* (Pallas 1788). The fauna from locs. M7813 and M7814 is based entirely on shell fragments recovered from two boreholes that penetrated a shell bed overlying the terrace platform at an approximate depth of -20 m. This fauna is composed of 24 species of mollusks (13 bivalves, 9 gastropods, 2 chitons), at least 9 species of miscellaneous invertebrates, and 1 mammal. The fauna is dominated by *Saxidomus giganteus* (Deshayes 1839) fragments, and lesser numbers of *Protothaca staminea* (Conrad 1837) and barnacles.

Faunas from both localities have a cool-water aspect with at least one extralimital northern species, in addition to the three to five species that occur today only as far south as the Monterey Bay area. Because these cool-water faunas are unlikely to have occurred at this latitude when coastal marine waters were warmer than present (such as 120,000 years BP, during the early part of marine oxygen-isotope stage 5), they probably date to the middle-to-late part of stage 5, when coastal marine waters were slightly cooler than they are at present. This age estimate is confirmed by amino acid racemization studies on *Saxidomus* (from loc. M7814) that yield enantiomeric ratios (D/L leucine = 0.41) equivalent to those of other cool-water faunas on the central California coast that date to substage 5a and thus are probably 80,000 to 85,000 years old.

SOME REMARKS ON BIOGEOGRAPHY

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The "infinite variation of nature" presents challenges and opportunities to those who attempt scientific generalization, prediction, or explanation. Valuable syntheses have made use of concepts of paleoclimate, plate tectonics, natural catastrophes, etc. to explain observed patterns of molluscan distribution. Exceptions can be found to all these generalizations and even the underlying concepts are imprecise on a geological time scale. I comment on the levels of uncertainty of these concepts.

OPTICAL AND SEM COMPARISON OF

Casmaria erinaceus AND
C. vibexmexicana RADULAE

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Radulae of two *Casmaria erinaceus* (Linnaeus 1758) and four *C. vibexmexicana* (Stearns 1894) specimens show less inter- than intraspecific variation. Protoconchs are similar, but shell markings are significantly different.

CATALOG OF SCANNING ELECTRON MICROGRAPHS OF *Cypraea* RADULAE: A STATUS REPORT

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SEM photographs have been made of the radulae and/or radular teeth of 60 species of *Cypraea*. The high resolution SEM images will aid other investigators who attempt optical examination of *Cypraea* radulae. I describe SEM techniques, discuss implications of radular types for a possible generic revision of the Cypraeinae, and show examples of inter- vs. intraspecific variation.

ANALYSIS OF MORPHOMETRIC VARIATION IN *Conus nux*: BIOGEOGRAPHIC PATTERNS IN THE EASTERN PACIFIC

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A hierarchy of analyses has been applied to the problem of biogeographic variation of external shell morphology in the neogastropod *Conus nux* Broderip 1833. Univariate, bivariate, and multivariate statistical analyses provide a measure of the within-sample and between-sample variability for populations extending through 30° of latitude and 30° of longitude. 743 individuals from 22 localities represent populations throughout the entire geographic range of *C. nux* from northern Mexico in the Gulf of California to the Galápagos Islands.

The principal pattern that emerges from the analyses is one of extreme homogeneity in external shell morphology. Groups of geographically related populations do not necessarily show the closest morphological similarity. Neither latitudinal nor longitudinal clinal patterns of morphometric variation are evident from the data. Likewise, island populations cannot be distinguished from mainland populations using morphometric criteria.

The patterns run counter to predictions that morphology should vary over such a broad geographic area with its wide range of environmental and oceanographic conditions. Both the morphological cohesiveness of the species and the tendency for some of the closest linkages in minor morphological variation to occur between geographically separated rather than adjacent populations require explanation. Patterns of gene exchange do not constitute a reasonable explanation given expected dispersal routes and barriers. Ecophenotypic differences related to microhabitat provides a more viable hypothesis.

This work was supported by the Theodore Roosevelt Memorial Fund of the American Museum of Natural History and a Grant-in-Aid of Research from Sigma Xi.

NEW RECORDS OF MARINE MOLLUSCAN SPECIES FOUND IN THE GULF OF CALIFORNIA AND ALONG THE WESTERN COAST OF THE UNITED STATES

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Current literature records more than 300 species of marine mollusks occurring both in the Gulf of California, Mexico and along the western coast of the United States. Eleven species are added to this record:

BIVALVIA

Chama arcana Bernard 1976
Macoma secta (Conrad 1837)
Protothaca staminea (Conrad 1837)
Ventricolaria fordii (Yates 1890)

GASTROPODA

Fissurella volcano Reeve 1849
Tegula aureotincta (Forbes 1852)
Pteropurpura festiva (Hinds 1844)
P. macroptera (Deshayes 1839)
Muricanthus nigrinus (Philippi 1845)
Megasurcula cooperi Arnold 1903
Ophioderma cancellata (Carpenter 1864)

ZOOGEOGRAPHIC IMPLICATIONS OF THE OCCURRENCE OF INDO-PACIFIC GASTROPODS ON THE WEST AMERICAN CONTINENTAL BORDERLAND

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Of the 47 species of gastropods (43 prosobranchs, Emerson 1978 and herein, Robertson 1979; 4 opisthobranchs, Bertsch 1979) with Indo-Pacific faunal affinities recorded in eastern Pacific waters, only 18 (38%) are known from the continental shelf of West America. *Pseudocypraea adamsoni* (Sowerby 1832), previously cited from the Galápagos Islands, is here recorded from the mainland of Ecuador, and *Mitra mitra* (Linné 1758), previously known from the Galápagos Islands and the west coast of Colombia, is also newly reported from West Panama. The vast majority of the 47 Indo-Pacific gastropods (62%) are reported in eastern Pacific waters only from the offshore islands, namely: Clipperton (with 32 taxa), Revillagigedo (6 taxa), Cocos (3 taxa), Galapagos (9 taxa), and Guadalupe (1 taxon). The only fossil representatives of living Indo-Pacific gastropods in west America are known from the Pleistocene of Guadalupe Island (*Cypraea cernica* Sowerby 1870; Kellogg 1976, Lindberg, et al. 1980) and from the Miocene of California (*Hastula albulula* [Menke 1843]), an Indo-Pacific species that also occurs in the Revillagigedo Islands (Bratcher and Burch 1971). Neogene fossils from California and Baja California previously identified as representatives of the living Indo-Pacific *Conus tessulatus* (Born 1778) are actually referable to *C. bramkampii* Hanna and Strong 1949, a New World species with a Neogene Caribbean cognate.

The small Indo-Pacific faunal element in the Panamic Province represents less than one percent of the more than 3,300 molluscan species (Keen 1971) living in tropical West American waters. The western Pacific faunal element is generally believed to have been introduced into these waters rather recently, largely by means of larval dispersion from populations in the central Pacific. Although the present oceanic current circulation

is supportive of this distributional pattern, there is little direct biological or paleontological evidence to substantiate this postulation.

Until recently, no Tertiary onshore marine deposits were known regionally, from southern Nicaragua northward, except on the Tres Marias Islands, off San Blas, Mexico and in the Gulf of California area (Woodring 1965, 1977; Addicott 1966). Indeed, the lack of marine Tertiary fossils from much of the middle West American Continental Borderland largely limited paleogeographic interpretations of the faunistic history of the modern Panamic Province to the regional Pleistocene record and to comparisons with the Tertiary record of the adjoining faunistic regions. Reconnaissance exploration along the west coast of mainland Mexico, northwest of Tehuantepec (Durham, Applegate and Espinosa-Arrubarrena 1981) recently discovered the presence of seven onshore Tertiary sedimentary basins on the North American Plate, indicating that not all of these sediments have been lost by subduction into the Middle American Trench system as previously believed. Four of the west Mexican basins have yielded marine sediments of Miocene and younger ages and offshore marine sediments were determined to contain marine Neogene sediments. These important findings should eventually provide paleontological data on the origin of the Indo-Pacific faunal elements in the eastern Pacific Ocean.

CENOZOIC BIOGEOGRAPHY OF TWO ACMAEID LIMPET SUBFAMILIES IN THE NORTHEASTERN PACIFIC: AN EXTANT AND A RADIATION

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[no abstract submitted]

HISTORICAL EVOLUTION AND APPLICATION OF THE PLEISTOCENE PROVINCE CONCEPT ALONG THE EASTERN PACIFIC MARGIN OF NORTH AMERICA

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Although the concept of modern biogeographic provinces has been discussed in biological circles for consid-

erably over one hundred years, the application of provincial concepts to Pleistocene faunas on the Pacific coast of North America occurred comparatively recently. Most of the early studies of Pleistocene faunas dealt with localities in southern California, and thus they encountered faunas that were predominantly warm in their temperature aspect. Subsequently, warm-water faunas were usually correlated with that of Arnold's "upper San Pedro series" (i.e. the Palos Verdes Sand), well known for its rich and diverse southern aspect.

Studies in the 1930's through the 1950's continued to recognize faunas that contained extralimital elements atypical of their geographic location. Various zoogeographic methods that were developed and applied in this period included the "median of mid-points" method of latitudinal analysis, and the quantification of the thermal changes necessary to support a fossil fauna at its present location. The former method proved to be not entirely satisfactory, mainly because it could not always predict the correct latitudinal equivalent, even for modern faunas. The latter technique has fallen into disuse since the early 1960's, although it was used extensively in the 1950's, when numerous warm-water faunas in Baja California and southern California were being described. At the same time, the presence of cool-water species, usually a minor component in these faunas, was usually attributed to upwelling, an explanation that should not be entirely abandoned.

The classic work on Pleistocene faunas and fossil molluscan provinces remains the 1958 Ph.D. dissertation of J.W. Valentine, published in 1961. Valentine defined three Pleistocene molluscan provinces, the Magdalenan (typified by faunas at Magdalena Bay, Baja California), the Verdean (typified by faunas from the Palos Verdes Hills), and the Cayucan (for the fauna at Cayucos). Each of these is now recognized to represent marine faunas warmer than their modern geographic counterparts, indicating a northward shift of marine isotherms in the late Pleistocene. However, when W.O. Addicott in 1966 examined Pleistocene faunas from central California to Puget Sound, Washington, he found just the opposite situation; the faunas indicated cooler-than-present conditions and a southward shift of marine isotherms. Addicott proposed the Nuevan province for these cool-water faunas, typified by that at Point Ano Nuevo, California, and restricted the Cayucan province to the area south of Cayucos. If Valentine's warm-water faunas were contemporaneous with Addicott's cool-water faunas, a very unusual hydroclimate must have existed off the California coast during the late Pleistocene. The problem remained unresolved until the advent of amino acid racemization studies, when dating these fossil faunas began in earnest. By the mid to late 1970's, it was apparent that the warm- and cool-water faunas were not contemporaneous, but represented different sea level stands that could be related to sea level maxima and climatic episodes documented in the burgeoning work on

isotopic fluctuations in deep sea cores. The previously named provinces have subsequently been restricted to two separate sea-level events. Future work on Pleistocene provinces is likely to concentrate on dating additional fossil localities and refining their provincial aspect, as well as trying to understand the provincial distributions of middle and early Pleistocene faunas.

FOSSIL VERMETIDAE FROM THE MIOCENE OF THE DOMINICAN REPUBLIC

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Although known since 1850, the remarkably well-preserved fossil horizons of the island of Santo Domingo (now the Dominican Republic), in the West Indies, have not been systematically studied until recently, aside from some short expeditions made there by such paleontologists as Dr. Carlotta Maury and Drs. Harold and Emily Vokes. Now, Dr. Peter Jung and colleagues from the Natural History Museum of Basel, Switzerland, have begun an intensive survey of the stratigraphy and the fauna. The fossils, meticulously collected and sorted to the family level, are being sent to specialists for identification.

Some 200 separate lots of vermetid gastropods were made available to me by Dr. Jung and by Dr. Emily Vokes. These seem to group into seven species, three in the genus *Petalochonchus*, three in *Serpulorbis*, and one in what I am provisionally calling *Eualetes*.

Two of the *Petalochonchus* represent *Petalochonchus*, s.s. — *P. (P.) domingensis* Sowerby 1850, and *P. (P.) laddfranklinae* Maury 1917. The third is the earliest record of the subgenus *Macrophragma*, *P. (M.) floridanus* Olsson & Harbison 1953.

The largest *Serpulorbis* is *S. papulosus* (Guppy 1866), which has a striking resemblance to *S. oryzata* (Mörch 1862) from the West Mexican area. Two smaller and poorly preserved species seem to be *Serpulorbis granifer* (Say 1824) and *S. virginicus* (Conrad 1839).

The seventh vermetid is a small form that I suspect is the ancestral stock of the group *Eualetes*, heretofore known only in the eastern Pacific. It has a distinctive mode of coiling and has pitted sculpture, especially in the early stages of growth. I am tentatively identifying it as the earliest record of *Eualetes mcgintyi* (Olsson & Harbison 1953). They cited the species from the Pliocene of Florida. It seems also to occur living in deep water in the Caribbean.

AN OCEANOGRAPHIC OVERVIEW OF THE GULF OF CALIFORNIA AND ITS HISTORICAL PERSPECTIVE

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Although there are a couple of references to collecting within the Gulf of California prior to 1860, no serious collecting activity began before John Xanthus made extensive collections at Cabo San Lucas, Baja California, Mexico, between January 1860 and July 1861. Within a short period following this, the Rev. J. Rowell, Major Rich, Capt. C.P. Stone, and Mr. Lewis Sloat also collected within the Gulf. These men were followed by W.J. Fisher in 1876 whose material was given to R.E.C. Stearns. The first large expedition was by the U.S.S. Albatross in 1891 which worked as far north in the Gulf as Guaymas. Subsequent important collections can be summarized as follows:

- 1921 —an expedition by the California Academy of Sciences
- 1929 —H.N. Lowe began the first of several collecting trips to the Gulf
- 1932 —an expedition by the Alan Hancock Foundation
- 1936 —the Templeton-Crocker expedition worked on the Gorda and Arena Banks; second expedition by the Alan Hancock Foundation
- 1937 —third Alan Hancock Expedition
- 1940 —Scripps Institution of Oceanography cruise to the Gulf; fourth expedition by the Alan Hancock Foundation
- 1957 —Puritan-American expedition
- 1960 —Ariel expedition

Since 1960 there have been dozens of collections made in all areas of the Gulf. Of significance, is the work done by Roy and Forrest Poorman in the "deep hole" off San Carlos Bay just north of Guaymas.

SUBTIDAL ECOLOGY OF THE BAHIA DE LOS ANGELES AREA OF THE UPPER GULF OF CALIFORNIA

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The Bahia de los Angeles area of the Gulf of California, Mexico offers an excellent opportunity for the study of subtidal ecology. A total of 62 dives were made in this area from May 1972 through June 1981. Tidal currents, which are especially strong off Mitlan, Smith, Piojo, and Angel de la Guarda Islands provide excellent conditions for suspension feeders. Especially common suspension feeders are:

PORIFERA

Acanus erithacus
Sphaciospongia sp.
Suberites sp.

CNIDARIA

Muricea californica
Eugorgia aurantica
Lophogorgia alba
Bunodosoma californica
Anthoplura dowii
Porites californica
Astrangia cortezi
Bathycyathus consagensis

BRYOZOA

Thalamoporella californica
Watersipora sp.

MOLLUSCA

Pteris sterna
Spondylus calcifer

The coral, *Astrangia cortezi* forms small branching colonies in the shallow subtidal. These colonies are generally less than 10 cm in size. *Astrangia cortezi* collected in deeper water (70-100 feet [20-29 m]) off Mitlan Island and Angel de la Guarda Island may be more than 50 cm in size. The branching *A. cortezi* and several species of gorgonians offer a complex habitat for many species of invertebrates.

VERMETIDAE OF THE GULF OF CALIFORNIA, MEXICO

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The vermetid fauna of the West-Mexican Gulf of California area comprises a record number of named genera and species. In fact, only four of the eleven generic units of the family are wanting. Thirteen species have been described, and several others await naming.

The principal source of the fauna seems to have been the warm water Tertiary Caribbean province, which extended into the eastern Pacific during Oligocene and Miocene time. Immigrants from the northwestern Pacific could also have drifted in from California during part of this time, especially when the North Pacific was walled off from the Arctic Ocean by a northern land bridge.

The vermetids of the Gulf have several species that are remarkably similar to Miocene forms in the West Indian area. For example, *Serpulorbis oryzata* (Mörch), which could easily pass as *S. papulosus* (Guppy) from the Dominican Republic. *Tripsycha tripsycha* (Pilsbry & Lowe) looks much like the large *Petalocnchus* from the Caribbean Miocene, but it lacks the internal spiral lamella of that genus, and the animal has a much larger operculum. Relationships of the fossil faunas of the eastern Pacific and western Atlantic must remain speculative, because crustal movements along the western Central American coast have erased most of that fossil record.

A REPORT ON THE GEMMELL COLLECTION

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We report on the origin of the Gemmell collection housed in the San Diego Natural History Museum and work on the collection now in progress. The material was collected along 100 miles of coastline from San Felipe to San Luis Gonzaga, Baja California, Mexico, from 1965 to 1976. We have had some problems identifying bivalves from this area.

LIMITATION OF PREY POPULATIONS BY
THE PREDATORY GASTROPODS *Muricanthus*
nigritus AND *Neorapana tuberculata*
IN THE BAY OF LA PAZ, MEXICO

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The impact of predation by *Muricanthus nigritus* (Phillippi 1845) and *Neorapana tuberculata* (Sowerby 1835) on their preferred prey items is reported. *M. nigritus* is a specialized predator of the oyster *Ostrea conchiphila* while *N. tuberculata* was observed feeding exclusively on the barnacle *Tetraclita squamosa*. Caging experiments indicate that *M. nigritus* limits the population size of *O. conchiphila* by consuming large quantities of both adults and juveniles. Similar experiments show that *N. tuberculata* preferentially consumes smaller specimens of *T. squamosa*, which may significantly impact recruitment and survivorship of the barnacle. These caging experiments further demonstrate that the feeding behavior of *M. nigritus* is not affected by predator density. *Neorapana tuberculata* apparently forages in an unsystematic pattern.

THE ONTOGENY OF SOME MURICID
SPECIES FROM THE
GULF OF CALIFORNIA, MEXICO

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Changes in growth of morphological features in the Muricidae are noted. These include the nature of the varix, episodic nature of sculpture, and differences between immature and mature growth. In addition, attention is drawn to the variability of the time between episodic growth of varices and the consequent affects of this on alignment of the varices with each other as well as to the axis of the shell. Conclusions are drawn that episodic growth may be consistent in some genera and inconsistent among other genera especially for the subfamily Ocenebrinae.

A NEW SPECIES OF *Anisodoris*
(GASTROPODA: OPISTHOBRANCHIA)
WITH A DISCUSSION OF THE TAXONOMY
OF THE DISCODORIDIDAE

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A new species of dorid nudibranch has been found subtidally in British Columbia, Canada, along the outer coast of Vancouver Island and the inner Strait of Georgia. Although large and conspicuous, it is easily confused with other local dorids. The distinguishing features of this species, its spawn and development have now been described. I placed it in the family Discodorididae because it possesses many similar smooth, hooked teeth, a large prostate gland and a glans penis. The generic placement of this new species is a problematic one as it does not fit the descriptions of any of the present genera. All the characters except that of penial armature fit the recently synonymized genus *Anisodoris*. Penial armature is common among the Discodorididae with generic descriptions sometimes allowing for the presence or absence of armature. The type of armature in this new species shows affinities with that of *Sebadoris*, but other characters differ from this genus. A preliminary cladistic analysis of the genera in the Discodorididae suggests Thompson's synonymy for *Anisodoris* is not valid. Accordingly, I put the new species into *Anisodoris* and enlarged the description to include the presence or absence of penial armature.

THE YELLOW-SPOT DISEASE OF THE
NUDIBRANCH *Tritonia diomedea*

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The large dendronotacean nudibranch, *Tritonia diomedea* (Bergh 1894), is afflicted with a parasitic infection characterized by small yellow spots in the body

wall. Tissue samples were taken from several diseased specimens obtained by dredging in Eastsound and Bellingham Bay, Washington, and examined in a transmission electron microscope. Several attempts were made to grow the parasite in culture.

In most of the nudibranchs examined, all of the parasitic cells were heavily encapsulated and necrotic. In two specimens, however, many cells were in the early stages of encapsulation, and it is from these that our information on ultrastructure has been derived. The parasitic cells are eukaryotic and are provided with a wall of thin scales. A single cell bearing a flagellum was found, and this observation, together with the presence of developing flagellar mastigonemes, indicates that the parasite can produce heterokont flagellated cells or zoospores although motile cells were not seen in cultures. A single organelle which we suggest is a bothrosome, and numerous plasmalemmasomes were present. Somatic cell divisions occur centripetally, with the inner scales of the parent cell wall participating in furrow formation, and the outer scales remaining around the daughter cells. The ultrastructural evidence indicates that the parasite is a member of the Thraustochytriaceae, a group of lower marine fungi generally thought to be saprobic.

Encapsulation of the parasitic cells is accomplished by concentric layers of host amoebocytes. The high level of encapsulating activity suggests that the nudibranch is not a natural host to the parasite.

CHEMICAL DEFENSE IN OPISTHOBRANCHS

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Opisthobranchs are delicate, commonly shell-less and often strikingly-colored gastropods that would seem to be ill-equipped to ward off predators. In spite of their apparent vulnerability, few animals have been recorded as predators of opisthobranchs. It has been suggested that utilization of some combination of behavior, coloration, spicules, nematocyst storage, and/or chemical secretions effectively deters opisthobranch predators. These chemical secretions may be either concentrated sulfuric acid or organic metabolites. In this paper we present evidence to support the hypothesis that noxious chemicals of dietary origin protect some opisthobranchs from potential fish predators.

Eight species of opisthobranchs from San Diego were investigated: *Cadlina marginata* MacFarland 1905, *C. limbaughorum* Lance 1962, *C. flavomaculata* MacFarland 1905, *Hypselodoris californiensis* (Bergh 1879), *Chromodoris porterae* Cockerell 1902, *Discodoris san-*

diegensis (Cooper 1863), *Dendrodoris albopunctata* (Cooper 1863), and *Tylodina fungina* Gabb 1865. In all cases, interesting secondary metabolites were isolated from the opisthobranch. The diets of all but one of these species were elucidated by field observations and gut analyses. These animals feed exclusively on specific sponges. Subsequent chemical analysis of the dietary sponges showed that the metabolites present in the opisthobranchs were exclusively dietary in origin. These sponges provided a larger source of the compounds for biological testing. Pelleted fish food was treated with measured amounts of these compounds and the feeding responses of one fresh-water and two marine fish were observed.

The details of this work are illustrated by focusing on the doris opisthobranch *Cadlina luteomarginata*. This opisthobranch contains a variety of sesquiterpene isonitriles and furanosesquiterpenes derived mainly from two sponges: *Axinella* sp. and *Dysidea amblia* De Laubenfels. Gut analyses and feeding observations complemented the chemical analyses. The anatomical location of these toxins was determined by dissection of individual opisthobranchs and chemical analysis of the individual parts. The metabolites were found to be concentrated in the dorsum of the animal; thus, the compounds must be transported from the gut and stored in the dorsum. Antifeedant assays of these compounds showed that they repelled fish at concentrations similar to those in the tissue of the opisthobranch's dorsum.

ALARM PHEROMONES FROM THE MARINE OPISTHOBRANCH *Chelidonura inermis*

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When molested, the marine opisthobranch *Chelidonura inermis* (Cooper 1862), secretes into its slime trail a bright yellow mixture of three major and several closely related minor substances. Collectively, these compounds induce an avoidance-alarm response in trail-following *C. inermis* at the concentration limits of 1×10^{-5} M. The three major compounds have been isolated and identified as 10-(3'-pyridyl)-3E,5E,7E,9E-decatetraen-2-one (navenone A), 10-phenyl-3E,5E,7E,9E-decatetraen-2-one (navenone B), and 10-(4'-hydroxyphenyl)-3E,5E,7E,9E-decatetraen-2-one (navenone C). The minor constituents of the mixture are proposed as the 3Z,5Z,7E,9E-isomers and the 3-methyl homologs of navenones A and B. The navenones appear to be produced in a specialized gland referred to in earlier studies as the "yellow gland" and to communicate the presence of predators within the species.

COMPARATIVE ZOOGEOGRAPHY OF HAWAIIAN AND PACIFIC BASIN NUDIBRANCHS

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The various opisthobranch orders and suborders show very different patterns of distribution. The herbivorous Anaspidea and Sacoglossa tend to have a greater number of species in tropic than in temperate or cooler waters. Nudibranchia and Cephalaspidea have the widest ranges of morphological variation and feeding habits and have the greatest number of species in all faunal regions.

Among the dorids, the sponge-feeding cryptobranchs predominate in warm waters, whereas bryozoan and tunicate feeding phanerobranchs tend to be most numerous in the colder and temperate waters.

Hawaiian opisthobranchs show Indo-Pacific faunal affinities that support larval dispersion in water currents as the source of origin of the fauna. Most of the data negate the probability that Hawaii's unique molluscan fauna was established through plate movement and island integration.

The subtidal density of opisthobranchs is much greater in the phytoplankton-rich waters of California than in the nutrient-poor, clear, subtropical waters of Hawaii. Most nudibranchs feed on the sessile filter-feeders that require a surrounding water medium filled with dissolved nutrients and small organisms.

OPISTHOBRANCH INFORMATION RESOURCES

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The first opisthobranch researchers had only occasional letters and library books as source material. All research was done on an individual basis and the completeness depended on the researcher. This situation persisted through the early 1800's and changed only when the major malacological journals started appearing around 1850. About the same time, Alder and Hancock's monograph appeared. Prior to this time it probably took an average of ten years for word of new species descriptions to travel around the world. The appearance of journals published on a regular basis allowed libraries and individuals to receive the majority of malacological systematic publications on a regular basis. This development brought the lag time for information travel around the world to about five years and simplified research for individuals. The next improvement was the appearance of *Zoological Record* in 1864. This publication abstracted many of the world's papers in one source. The lag time for information dissemination was down to about three years. No dramatic new opisthobranch information resources appeared until Sherborn published "Index Animalium" in 1902. This listing of names helped bridge the information gap. In the late 1930's Hoffman published a large bibliography of opisthobranch literature in Bronn's "Klassen und Ordnungen des Tierreichs". The next forty years were almost void of new information and even papers on opisthobranchs. In 1969, at a Western Society of Malacologists meeting at Asilomar, a group of about twelve people discussed the need for better information handling and brought about the "Opisthobranch Newsletter" which provided citations, species names, current events, and information on a monthly basis and brought the information delay down to weeks rather than years. Today anyone can own a terminal or home computer and have immediate access to large volumes of information. In the future, every researcher will be able to link their information resources together via communication links and computers. In addition, microfilm and video storage systems will provide compact storage for copies of all work previously published.

CURRENT RESEARCH IN OPISTHOBRANCH/ALGAE SYMBIOSIS

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[no abstract submitted]

A PRELIMINARY SURVEY OF *Nitidiscala tinctoria* ALONG THE CALIFORNIA COAST

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Nitidiscala tinctoria (Carpenter 1864) [= *Epitonium tinctorum* Carpenter] commonly occurs in the rocky intertidal zone in association with the anemone *Anthoplura elegantissima* (Brandt 1835). It ranges from Forrester Island, Alaska to Magdalena Bay, Baja California, Mexico. The purpose of this study is to document differences within and between California populations, north and south of Point Conception. The northern California collecting site was in Horseshoe Cove, adjacent to the Bodega Bay Marine Lab, Sonoma County. The rocky headland at Carpinteria Beach State Park, Santa Barbara County, was the primary collecting site in southern California.

The shell of *Nitidiscala tinctoria* can grow to over 10 mm in length with 3 nuclear whorls and 8 body whorls with about 12 thin costae continuous from whorl to whorl. It was suggested by A.M. Strong in 1941 that *N. tinctoria* occurring north of Point Conception were larger than southern specimens and that shells of the same length were heavier and broader with less whorls and costae in northern California. Snails found in Bodega Bay were often larger than snails found at Carpinteria. However, when snails of the same length from northern and southern California were compared, their weight, width, number of whorls, and number of costae did not differ significantly.

These mesogastropods are protandric hermaphrodites, changing sex only once during their life cycle. In comparing snails of equal lengths from north and south of Point Conception, smaller males and females were found at Carpinteria than in Bodega Bay.

The size frequency distribution of Bodega Bay *Nitidiscala tinctoria* populations fluctuate seasonally. An

influx of small snails may be found as early as January or as late as June. These small snails grow throughout the summer until fall when large females and egg cases are more abundant than at any other time of the year. The abundance of snails decreases throughout the winter until the veligers, apparently released during the fall, metamorphose and settle in the intertidal zone. In Carpinteria seasonal variation is not apparent, as it is common to find both large and small snails with egg masses throughout the year.

THE ROLE OF NEOGENE SEABIRDS IN THE INTRODUCTION OF ANOMALIES TO PACIFIC COAST FOSSIL ASSEMBLAGES

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Associations of bathymetrically anomalous fossils, a phenomenon particularly common in shallow-water, marine Neogene faunas of the North American west coast, have yet to be explained adequately. No known physical transport processes can selectively move species upslope from deep water into diverse, nearshore, shallow-water habitats. Previously proposed biological explanations are based on undocumented phenomena. We document bathymetric anomalies in Recent mollusc accumulations on Southeast Farallon Island, California that are created by the activities of diving marine birds. Application of these observations to patterns in the Neogene fossil record is direct, involving the same genera and often the same species. We argue that during the Neogene diving marine birds were more diverse and abundant than at present and could have transported specimens upslope in sufficient quantity to have contributed anomalous species to the Neogene fossil record. Specific examples from the literature are discussed.

THE DISTRIBUTION OF BIVALVES ACROSS THE CONTINENTAL SHELF OF THE ALASKAN ARCTIC

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Western Beaufort Sea bivalves were quantitatively sampled with a 0.1 m² Smith/McIntyre grab. Nine stations from 5 to 100 m were occupied along a transect line offshore of Pitt Point, Alaska. Seasonal samples (Fall, Winter, Spring, Summer) from depths of 25, 55, and 100 m were collected during a one-year period. Over 10,000 individuals representing 49 bivalve species were identified. There appears to be distinct inner, mid, and outer shelf species assemblages. The dominant species associated with these assemblages are *Boreacola vadosa* (Bernard 1979), *Portlandia arctica* (Gray 1824), and *Astarte montagui* (Dillwyn 1817) respectively. Annual variation of bivalve density and diversity was not significant during the summers of 1976, 1977, and 1978. Significant seasonal variations were found in the abundance and size frequencies of *P. arctica* and *A. montagui*.

ON *Xenophora digitata* von MARTENS 1878

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Xenophora digitata von Martens 1878 is a unique species among the unusual Xenophoridae. The name means fingers of which *X. digitata* has 8-10. The animal builds a flange of fingers around the periphery of each whorl upon which are agglutinated tiny bits of shell that conform perfectly to the shape of the fingers. Other species of Xenophoridae build different types of flanges which serve as camouflage, protection and facilitate movement over the substrate while giving the shell stability.

The fossil *Xenophora conica* Dall 1890, known from the Eocene of Mississippi, has the periphery extended in scalloped points which bear small extraneous pieces of shell and differs from any other American Tertiary species. In the Paleotertiary Pliocene deposits of northern Italy, *X. testigera* Bronn 1832 was found. The shell is conically depressed, with the lower margin indicating

shells which are glued to the truncated spines. Both species are undoubtedly ancestral to Recent *X. digitata* found along the west central and north east coasts of Africa.

Dr. Eduard von Martens in 1878 described *Xenophora digitata* for the first time: "Shell densely corrugated, final periphery produced sharp planes on the points of which alien shells are agglutinated. Foreign shells found only on the tip of each single projection." W. Adams and J. Knudsen (1955) described *X. digitata* as having shells which were agglutinated to the base of the spines and which left their imprints on the sculpture of the shell. The fingers vary in length from 10-15 mm growing larger as the whorls increase in circumference. The flange spreads horizontally creating stability, and raising the height of the base an unvarying 20 mm above the substrate. This species is found in depths of approximately 30 fathoms (55 m).

GEOGRAPHIC VARIATION IN *Cypraea caputserpentis* AND AN INTERPRETATION OF ITS RELATIONSHIP WITH *C. capudraconis*

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A highly variable species both in shell morphology and color, is the serpent's head cowry, *Cypraea caputserpentis* Linné 1758. Cosmopolitan in distribution, its range extends from South Africa to Hawaii. In their prodrome on cowries, the Schilders recognized seven subspecies of *C. caputserpentis* based on unique geographic differences in shell morphology and color.

In 1971, they revised their classification to four subspecies: two Australian forms *C. c. kenyanae* (Schilder & Schilder 1938) and *C. c. caputanguis* Philippi 1849, which they describe as parallel clines; the Hawaiian *C. c. caputophidii* (Schilder 1927), also described as a cline; and the nominal subspecies. A closely related species *C. capudraconis* Melvill 1888, is found only on Easter Island and Sala y Gomez Island.

In 1958, Griffiths published a quantitative study on *Cypraea caputserpentis* and *C. capudraconis*. He found *C. capudraconis* to be more distinct than any of the subspecies of *C. caputserpentis* on the basis of 24 shell variables. The Hawaiian *C. c. caputophidii* was found to be the only distinct, hence valid subspecies.

The purpose of this study is to examine geographic variation in *Cypraea caputserpentis* using multivariate statistical techniques. Once the patterns of variation are

understood, the relationship of *C. caputdraconis* to the various populations can be interpreted, hopefully elucidating its origin. The results that follow can be considered preliminary to a final, more comprehensive analysis when more specimens can be obtained.

Specimens were obtained from 17 populations through shell supply stores, museum loans, and personal collections. Samples were believed to be random as their variation conformed to samples personally collected. On the basis of past taxonomic discussion, 19 morphological shell variables were derived and measured. Color was omitted due to the difficulty in obtaining a quantitative measurement, and the likely correlation with diet as well as the possibility of obtaining faded specimens.

Of the original 19 variables, eight were found to be significantly different among samples in an analysis of variance. Cluster analysis formed groups reflecting similarities in overall size, but displayed no geographic trends, or subspecific groupings. Geisser classification, a multivariate technique that classifies individuals into the sample they most closely resemble, correctly classified 74% of the individuals. Samples from populations at the ends of the species distribution — South Africa, Tahiti, and Maui — were more distinct (90-100% correct classification) than samples from the center of distribution — Philippine Islands and Solomon Islands — which were very similar (40-50% correct classification). The analysis suggests an overall clinal pattern of variation but misses (i.e. incorrect classifications) indicate a mosaic pattern.

Canonical analysis of discriminance was used to examine contrasting patterns of geographic variation. The South African sample was found to be somewhat unique on the first axis, an axis displaying differences in environmentally related size variables. The second axis was interpreted to be one reflecting differences in genetic characters — aperture width, left anterior terminal ridge — and provided some separation of the Hawaiian sample from the others.

When the sample of *Cypraea caputdraconis* was added to the analysis, it became the most unique group. Differences were interpreted to be a combination of genetic and environmental factors. The Hawaiian samples — Oahu and Maui — were the most similar to *C. caputdraconis*. Similarities in color characters confirm this morphological relationship. It is hypothesized that Hawaii and Easter Island once shared a common fauna. Subsequent changes in current patterns, island distributions, as well as the invasion of new species could well have isolated this ancient fauna, and allowed the observed genetic differentiation to occur. Perhaps the Hawaiian Island populations maintain some gene flow with the rest of the Pacific populations.

TAXONOMY AND EVOLUTION OF THE GENUS *Monadenia* (GASTROPODA: PULMONATA)

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Three subgenera of *Monadenia* Pilsbry 1895 are recognized: *Monadenia sensu stricto*, inhabiting a humid coastal strip from southeast Alaska to central California; *Corynadenia* Berry 1940, patchily distributed along the west slope of the central Sierra Nevada; and a new subgenus mostly confined to the Klamath Mountains of California, where it is parapatric with *Monadenia s.s.*

Cladistic analysis groups *Corynadenia* with the new subgenus, with *Monadenia s.s.* less similar to either. The distribution of apomorphies falsifies all possible phylogenetic trees for the group except that which is isomorphous with the cladogram. Consequently, the proposed phylogenetic history of *Monadenia* consists of (1) a dichotomy between *Monadenia s.s.* and the common ancestor of *Corynadenia* and the new subgenus, followed in time by (2) a dichotomy between the latter two subgenera.

Three fossil forms referred to *Monadenia* are present in the John Day Formation (late Oligocene to early Miocene) of central Oregon. Shell types resembling modern *Monadenia s.s.* and the *Corynadenia* -new subgenus group are present. The Bridge Creek Flora (age 31.5 million years) from the lower member of the John Day Formation represents a mixed mesophytic forest dominated by broad-leaved deciduous trees, in a temperate climate with ample summer rainfall — similar to modern hardwood forests of eastern North America and eastern Asia. The source of the John Day land mollusks is the vertebrate-rich middle member, about 25 million years old; contemporaneous floras are also mixed mesophytic, possibly somewhat warmer than the Bridge Creek Flora. The Cascade Range was not a significant climatic or vegetational barrier at that time. The inferred environment may have supported greater intragenetic snail diversity than now seen in any forests of the west, much as the hardwood forests of the eastern United States now support diverse Polygyridae. Part of the early diversification of *Monadenia* probably involved habitat partitioning between ground-dwelling and arboreal species.

With subsequent shift from summer-wet to summer-dry climate, and depauperization of the woody flora by the Pliocene, substantial allopatry between the two stocks of *Monadenia* may have arisen, with the *Corynadenia*-new subgenus group inhabiting the drier interior regions and *Monadenia s.s.* exploiting a tendency toward eurytopy in humid environments. Thermal parameters now limit the ranges of the subgenera. A modern isoth-

ermal configuration suggests a model for conditions that may have enforced geographic separation between *Corynadenia* and the Klamath Mountains subgenus, leading to their differentiation.

THE WEST AMERICAN DONACIDAE: A TAXONOMIC STUDY

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I have been preparing a review of the eastern Pacific Donacidae and have studied the available type specimens and several of the larger institutional collections. Surprises among the type specimens and sufficient material to understand variability and clinal patterns have shown that several common species will have to be known by as-yet unfamiliar names.

I recognize the following:

Donax (*Chion*) *punctatostriatus* Hanley 1843 [synonym: *D. sowerbyi* Bertin 1881] Laguna San Ignacio, Baja California, throughout the Gulf of California to Manzanillo, Colima, Mexico

Donax (*C.*) *caelatus caelatus* Carpenter 1857 Bahía de las Animas, Baja California Norte, and Guaymas, Sonora, Mexico to Golfito, Costa Rica

Donax (*C.*) *caelatus* (new subspecies) Coan Canoa, Ecuador to Talara, Peru

Donax (*C.*) *obesulus* Reeve 1854 [synonyms: *D. peruvianus* Deshayes 1855; *D. radiatus* Valenciennes 1827, non Gmelin 1791; *D. aricanus* Dall 1909; *D. mancorensis* Olsson 1961] Canoa, Ecuador to Bahía Moreno, Chile

Donax (*C.*) *ecuadorianus* Olsson 1961 Punta Ampala, El Salvador to between Manta and Manglaralto, Ecuador

Donax (*C.*) *obesus* Orbigny 1845 Punta Ampala, El Salvador to Canoa, Ecuador; perhaps as far north as Zihuatanejo, Mexico; perhaps as far south as Paita, Peru

Donax (*C.*) *culter* Hanley 1845 [synonyms: *D. contusus* Reeve 1854; *D. conradi* Reeve 1854, ex Deshayes MS; *D. bitinctus* Reeve 1855] Isla San Ignacio, Sonora, and La Paz, Baja California to Acapulco, Guerrero, Mexico

Donax (Group of *D. assimilis*)

D. assimilis Hanley 1845 [synonyms: *D. panamensis* Philippi 1848; *D. curtus* Sowerby 1866; *D. reevei* Bertin 1881] Punta Ampala, El Salvador to Gulf of Guayaquil, Ecuador; possibly as far north as Zihuatanejo, Mexico

D. dentifer Hanley 1843 [synonym: *D. paytensis* Orbigny 1845] Guatemala to Playas, Ecuador; possibly as far south as Paita, Peru

D. asper Hanley 1845 [synonym: *D. granifer* Reeve 1854, ex Deshayes MS] Punta Ampala, El Salvador to Zorritos, Peru

Donax (*Machaerodonax*) *carinatus* Hanley 1843 [synonyms: *D. rostratus* C.B. Adams 1852; *D. culminatus* Carpenter 1857] Estero de tastiota, Sonora and Bahía Magdalena, Baja California Sur, Mexico to Mancora, Peru

Donax (*M.*) *transversus* Sowerby 1825 Altata, Sinaloa, Mexico to Paita, Peru

Donax (*Amphichaena*) *kindermanni* (Philippi 1847) [synonyms: *D. petallinus* Reeve 1854, ex Deshayes MS; *Amphichaena gracilis* Mörch 1860] Bahía Tenacatita, Jalisco, Mexico to Acajutla, El Salvador; possibly to Panama

Donax (*Paradonax*) *californicus* Conrad 1837 [synonym: *D. navicula* Hanley 1845] Mugu Lagoon, California to and throughout the Gulf of California, Mexico to Puerto Pizarro, Peru

Donax (*P.*) *gracilis* Hanley 1845 Bahía San Bartolome, Baja California Sur to and throughout the Gulf of California, Mexico to Negritos, Peru

Donax (Group of *D. gouldii*)

D. gouldii Dall 1921 [synonyms: *D. obesus* Philippi 1851, & *D. obesus* Gould 1851, non Orbigny 1845; *D. laevigatus* Reeve 1845, ex Deshayes MS, non Gmelin 1791; *D. abruptus* Carpenter 1857, 1864, ex Gould MS, in synon.] Pismo Beach, California to Arroyo Conejo, Baja California Sur, Mexico

Donax (new species) Coan
Salinas, Ecuador to Arica, Chile

Iphigenia altior (Sowerby 1833) [synonym: *I. ambigua*
Bertin 1881] Mazatlan, Mexico to Bayovar, Peru

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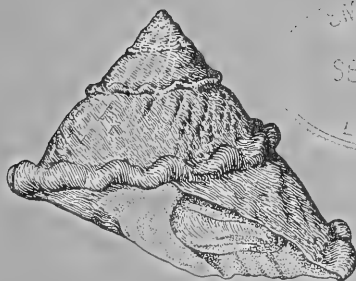


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THE WESTERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT

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Redlands, California
20-23 June, 1982

Volume 15

THE WESTERN SOCIETY OF MALACOLOGISTS

Annual Report

Volume 15

**Redlands, California
20-23 June 1982**

Issued: AUG 30 1983

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The **Annual Report** of the Western Society of Malacologists is based on its yearly meeting. Distribution of the **Annual Report** is free to regular and student members who are, at the time of issue, in good standing. Membership dues are \$7.50 and \$3.00 for students. Others of a regular member's family may join for an additional \$1.00; each family receives only one **Annual Report**.

The Western Society of Malacologists has issued two **Occasional Papers**—No. 1, “‘Sea Shells of Tropical West America’: Additions and Corrections to 1975” by Myra Keen & Eugene Coan; and No. 2, “A Catalogue of Collations of Works of Malacological Importance” by George E. Radwin & Eugene Coan. Each was priced at \$2.50. At this moment, the first is out of print. The second is still available.

Correspondence regarding membership and orders for additional or back issues of the **Annual Report** or the **Occasional Papers** should be addressed to the current W.S.M. Treasurer, Mrs. Margaret Mulliner, 5283 Vickie Drive, San Diego, CA 92109.

When longer papers are included in the **Annual Report** or the **Occasional Papers** they are reviewed by two members of the Editorial Board in addition to the Editor.

NOTICE OF THE 16th ANNUAL MEETING OF THE WESTERN SOCIETY OF MALACOLOGISTS

The 1983 meeting of the Western Society of Malacologists will be held jointly with the American Malacological Union in Seattle, Washington, 7-13 August 1983, on the campus of the University of Washington. Field trips and a symposium on avian molluscivores are scheduled. In addition, there will be exhibits, the annual shell auction, and a banquet. A call for contributed papers will be issued early in 1983. For further information, please contact WSM Secretary: Mrs. Katherine Stewart, 19 La Ranchera, Carmel Valley, CA 93924.

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106 Terrace Drive
Chico, CA 95926
[meets twice a month, 2nd Wed 9:30 am in members' homes, and 4th Wed 7:30 pm at Pleasant Valley Recreation Center, North Avenue, Chico, CA]

Oregon Society of Conchologists

Dr. Byron W. Travis
4324 NE 47th Avenue
Portland, OR 97218
[meets first Sunday of each month, 1:30 p.m., in private homes; announcements given in monthly paper or by card]

Conchological Club of Southern California

c/o Malacology Section
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, CA 90007
[meets in Museum Lounge, 7:30 p.m., first Monday of each month, unless a holiday, then on Wednesday of same week]

Pacific Shell Club

c/o Malacology Section
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, CA 90007
[meets in Museum Lounge first Sunday of each month, 1:30 p.m., October through June]

Hawaiian Malacological Society

P.O. Box 10391
Honolulu, HI 96816
[meets first Wednesday of each month, 7:00 p.m., at First United Methodist Church, Victoria & Beretania Streets, Honolulu; December party at another location]

San Diego Shell Club

c/o 3883 Mt. Blackburn Avenue
San Diego, CA 92111
[meets third Thursday of every month, Casa del Prado, Balboa Park]

Houston Conchology Society

c/o Constance Boone
3706 Rice Boulevard
Houston, TX 77005
[meets fourth Wednesday of August, September, October, January, February, March, April, and May; third Wednesday of November, at the Houston Museum of Natural Science]

Santa Barbara Malacological Society

P.O. Box 30191
Santa Barbara, CA 93105
[meets third Friday of every month, 7:30 p.m., Santa Barbara Museum of Natural History, 2559 Puesta del Sol]

Northern California Malacozoological Club

121 Wild Horse Valley Drive
Novato, CA 94947
[meets third Thursday of each month at the California Academy of Sciences]

Southwestern Malacological Society

c/o Mrs. Carol C. Skoglund
3846 E Highland Avenue
Phoenix, AZ 85015
[meets third Wednesdays, September through May, 7:30 p.m., Asbury United Methodist Church, 1601 West Indian School Road, in auxiliary rooms]

Yucaipa Shell Club

c/o Mousley Museum of Natural History
35308 Panorama Drive
Yucaipa, CA 92399
[meets third Sunday of every month except August, 2:00 p.m., in the Museum]

MINUTES, EXECUTIVE BOARD MEETING WESTERN SOCIETY OF MALACOLOGISTS

The meeting was called to order by President Dr. Donald Shasky. Present were Mrs. Margaret Mulliner, Mrs. Carole Hertz, Mrs. Sandra Gardner, Dr. Eugene Coan, Mrs. Carol Skoglund, and Mr. Bruce Fowler.

President Shasky appointed Bruce Fowler acting Secretary in the absence of Mrs. Katherine Stewart. Minutes from the 1981 Executive Board meeting were read by Mr. Fowler. A motion was made by Carol Skoglund to accept the minutes as corrected. The motion was seconded by Carole Hertz; the motion carried.

The Treasurer's Report was read by Margaret Mulliner. A motion was made by Carol Skoglund to accept the report as given. The motion was seconded by Carole Hertz; the motion carried.

Carol Skoglund, acting for the Nominating Committee, proposed the following slate of officers:

President	Mr. David Lindberg
1st Vice President	Dr. George Kennedy
2nd Vice President	Mrs. Sandra Gardner
Secretary	Mrs. Katherine Stewart
Treasurer	Mrs. Margaret Mulliner
Member-at-Large	Mr. Bertram Draper
Member-at-Large	Dr. Judith Terry-Smith

A motion was made by Carole Hertz to accept the slate as presented. The motion was seconded by Margaret Mulliner; the motion carried.

Carol Skoglund, acting for David Lindberg, motioned that we meet with the American Malacological Union in Seattle, Washington 3-7 August 1983 (subject to the approval of the Executive Board of the AMU), with the following qualifications: 1) WSM members attending will pay regular AMU registration fees for the meeting; 2) WSM will

publish its own Annual Report with abstracts of papers given by members of the WSM; and 3) AMU Bulletin for the meeting will be available to those WSM members wishing to purchase it on an individual basis. The motion was seconded by Carole Hertz; the motion carried.

Carol Skoglund mentioned that the Southwestern Malacological Society is providing a grant to the runner up in the WSM Student Grant award, and that the SMS would like the WSM Student Grant Committee to select the winner of their award. Margaret Mulliner suggested that the WSM Secretary write a letter of thanks for the monetary donations from the various shell clubs. A motion was made by Margaret Mulliner to authorize, in recognition of members contributions, \$600.00 for the WSM Student Grant for 1982-1983. The motion was seconded by Carol Skoglund; the motion carried.

The raising of dues was discussed, and no increase was proposed at this time.

A discussion of the duties of the Secretary and the Treasurer was held. In order for mailings to be consolidated it was suggested that there be closer communication between these two offices. No formal motion was made because the duties are stated in the WSM Bylaws.

There was a discussion of our tax-exempt status and the tax deduction status of auction specimens and other donations. Treasurer Margaret Mulliner will appraise the status upon research into the area.

A motion was made by Carol Skoglund to authorize the WSM Editor to print 300 copies of the Annual Report at an approximate cost of \$1500.00. The motion was seconded by Sandra Gardner; the motion carried.

As there was no further business, President Shasky adjourned the meeting.

MINUTES, ANNUAL BUSINESS MEETING WESTERN SOCIETY OF MALACOLOGISTS

The meeting was called to order by President Dr. Donald Shasky. Bruce Fowler presented the Secretary's Report (having been appointed acting Secretary). A motion was made by Jules Hertz to accept the Report as read. The motion was seconded by Helen DuShane; the motion carried.

Carol Skoglund presented the Nominating Committee's recommended slate of officers for 1982-1983:

President	Mr. David Lindberg
1st Vice President	Dr. George Kennedy
2nd Vice President	Mrs. Sandra Gardner
Secretary	Mrs. Katherine Stewart
Treasurer	Mrs. Margaret Mulliner
Member-at-Large	Mr. Bertram Draper
Member-at-Large	Dr. Judith Terry-Smith

A motion was made by Dr. William Emerson to accept the slate of officers, as there were no nominations from the floor. The motion was seconded by Pat LaFollete, the motion carried.

Carol Skoglund, acting for David Lindberg, motioned that we meet with the American Malacological Union in Seattle, Washington 3-7 August 1983 (subject to approval by the AMU Executive Board) with the following qualifications: 1) WSM members attending will pay regular AMU registration fees for the meeting; 2) WSM will publish its own Annual Report with abstracts of papers given by

members of the WSM; and 3) AMU Bulletin for the meeting will be available to those WSM members wishing to purchase it on an individual basis. The motion was seconded by Dr. Eugene Coan. There was discussion of alternatives and consequences of the meeting; the motion carried.

Margaret Mulliner presented the Treasurer's Report. A motion was made by Carole Hertz to accept the Report as presented. The motion was seconded by Carol Skoglund; the motion carried.

President Shasky made the following appointments: Auditing Committee—Jean Cate, Barbara Good, and Kay Webb; Editor—Michael G. Kellogg; and Student Grant Committee—present members.

Carol Skoglund announced the Student Grant from the Southwestern Malacological Society will provide an award for the runner up of the WSM Student Grant.

The old WSM gavel was found and a discussion followed as to the disposition of both gavels. Dr. Keen suggested that the replacement gavel should be given to the President of the AMU at the Seattle meeting. A motion was made by Pat LaFollete to have an appropriate plate made (and/or have the old plate brought up to date) with the names of the Presidents and dates. The motion was seconded by Bert Draper; the motion carried.

Dr. William Emerson moved that the Business Meeting be adjourned. The motion was seconded by Carole Hertz.

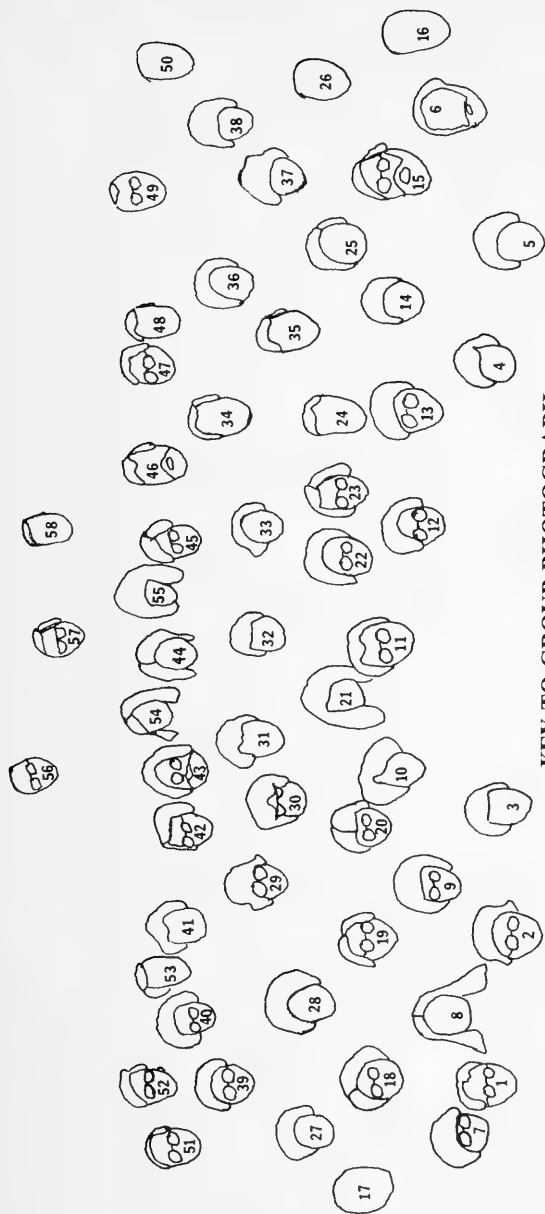
TREASURER'S REPORT

1 July 1981 through 1 September 1982

Balance as of 1 July 1981				\$3154.42
		INCOME		
Dues:				
1980 1 Regular	\$ 7.50			
1981 15 Regular	112.50			
3 Family	3.00			
3 Student	9.00			
1982 184 Regular	1380.00			
24 Family	24.00			
8 Student	24.00			
1983 4 Regular	30.00	\$1581.00		
Publications:				
Annual Reports				
9 @ \$5.00	45.00			
11 @ \$7.50	82.50			
Occasional Papers				
1 @ \$2.50	2.50			
(postage)	.50			
Conference photos				
2 @ \$3.00 (1981)	3.00			
13 @ \$5.00 (1982)	65.00	201.50		
Donations	281.23	281.23		
Savings Account Interest	145.72	145.72		
Convention Deposits	4763.90	4763.90		
Annual Shell Auction	679.50	679.50	\$7652.85	\$10807.27
		EXPENSES		
Secretary's expenses	\$ 349.93	\$ 349.93		
Historian's expenses	7.00	7.00		
Treasurer's expenses	65.35	65.35		
Filing fee non-profit organization	2.50	2.50		
AMU dues	13.00	13.00		
COA dues	5.00	5.00		
Petty cash fund	100.00	100.00		
Miscellaneous expenses	15.50	15.50		
1982 Convention expenses	4066.92	4066.92		
Annual Report, Volume 14:				
Typesetting	563.90			
Printing	355.67			
Postage	205.88	1261.81	\$5887.01	\$5887.01
Balance at end of period				\$4920.26

Margaret Mulliner, Treasurer





KEY TO GROUP PHOTOGRAPH

1. Myra Keen
2. Rosemary Adams
3. Billee Dilworth
4. Joan Sherman
5. Edith Abbott
6. Eugene Coan
7. Tomoye Suematsu
8. Tami Suematsu
9. Barbara D. Corner
10. Ursula Shasky
11. Donald R. Shasky
12. Margaret Mulliner
13. Carol Skoglund
14. Jody Woolsey
15. Patrick LaFollette
16. David K. Mulliner
17. Anthony D'Attilio
18. Mary Larson
19. Jean Cate
20. Forrest Poorman
21. Donna Vaughan
22. Lois Pitt
23. Lucinda Draper
24. Bill Pitt
25. James H. McLean
26. Bertram Draper
27. Sandra Gardner
28. Deena Brawerman
29. Kay Weber
30. Bernie Ciampton
31. Kay Webb
32. Twila Bratcher
33. Charlotte Norrid
34. Harold Norrid
35. Paul Newby
36. Liz Petit
37. Wendy Koch
38. Tony Phillips
39. Emily Vokes
40. Barbara Good
41. Helen Dushane
42. Audrey Holiman
43. Paul Scott
44. Leslie Harris
45. Bruce Fowler
46. Ron Abler
47. Jules Hertz
48. Richard Petit
49. Robert Koch
50. Roy Poorman
51. Harold E. Vokes
52. Ronald G. Velarde
53. Wayne Holiman
54. Carole Hertz
55. Sally Bennett
56. Steve Long
57. Bill Emerson
58. Richard Callaway

Others attending, but not in group photograph: Minni Ball, Hugh Bradner, Madge Bradner, Conrad Clausen, Ralph Ferguson, Mr. & Mrs. F.O. Pierce, Jo Ramsaran, Lee Schremp, Gerard Venken, Ruth White

PAPERS PRESENTED TO THE FIFTEENTH ANNUAL MEETING: TITLES AND ABSTRACTS

VERMETIDAE OF THE TROPICAL EASTERN PACIFIC

A. Myra Keen

Department of Geology, Stanford University
Stanford, CA 94305

To update the allocations of the 14 named species of Vermetidae cited in Keen (1971) requires only a few minor changes, mostly at the subgeneric level. There are, also a few range extensions that should be reported. The name changes result from a chance I have had to study closely the fossil vermetids of the western Atlantic that are ancestral to our present Pacific fauna.

Vermetus

493. *Vermetus (Thylaeodus) contortus* (Carpenter, 1857) Head of the Gulf of California to Oaxaca, Mexico*
494. *Vermetus (Thylaeodus) indentatus* (Carpenter, 1857) Head of the Gulf of California to Tres Marias Is.*

One or more new forms in northern end of the Gulf.

Petalococonchus

Suggested redefinition of *P. (Petalococonchus)*, s.s.: Teleoconch attached only in early stages; coiling regularly helical, either with a hollow cone as axis or in a tight spiral.

495. *Petalococonchus (Petalococonchus) complicatus* Dall, 1908 Colima, Mexico, to the Galapagos Is.*
496. *Petalococonchus (Petalococonchus) flavescens* (Carpenter, 1857) Mazatlan, Mexico, area
497. *Petalococonchus (Petalococonchus) innumerabilis* Pils. & Olsson, 1935 Mazatlan area to Tumbez, Peru
498. *Petalococonchus (Macrophragma) macrophragma* (Carpenter, 1857) Cape San Lucas, Baja Calif. to El Salvador. ? Panama

One or more new species in Gulf of California and Panama area.

Tripsycha

499. *Tripsycha tripsycha* (Pilsbry and Lowe, 1932) Head of the Gulf of California to Acapulco, Mexico

Eualetes Keen, 1971

Resembling *Serpulorbis* but with an operculum; early whorls pitted

500. *Eualetes centiquadrus* (Valenciennes, 1846) Puerto Penasco to El Salvador*
501. *Eualetes tulipus* (Chenu, 1843) Panama Bay

Serpulorbis

502. *Serpulorbis eruciformis* (Morch, 1862) Head of the Gulf of California to Acapulco*
503. *Serpulorbis margaritaceus* (Chenu, 1844) La Paz, Baja California, to Oaxaca*
504. *Serpulorbis oryzata* (Morch, 1862) La Paz, Baja California, to Acapulco
- 504-x? *Serpulorbis* (?) *sutillis* (Morch, 1862) "Gulf of California"

Dendropoma

505. *Dendropoma lituella* (Morch, 1862) Southern California to La Paz, Baja California
Dendropoma, n. sp. 20 meters depth, off La Paz
Dendropoma sp. Oaxaca

*new distributional records

NEW DEVELOPMENTS IN THE FAMILY EPITONIIDAE

Helen DuShane

15012 El Soneto Drive
Whittier, CA 90605

In working with the family Epitoniidae, I have found some new information:

- (1) *Nitidiscala statuminata* (Sowerby 1844), a previously dredged species, has been taken live, intertidally from silty mud in Panama Bay.
- (2) *Cirsotrema togatum* Hertlein & Strong 1951, known only as a Recent species has been collected in Panama as a Pliocene fossil (formation uncertain at this time).
- (3) Two epitoniids, *Nitidiscala basicum* and *Nitidiscala zephyrium* both Dall 1917, are relegated to the synonymy of *Scaloria lamellosum* Lamarck 1822, with a world wide distribution.

UPDATE OF MURICIDAE FOR "SEA SHELLS OF TROPICAL WEST AMERICA" (as of June 1982)

Emily H. Vokes

Department of Geology
Tulane University
New Orleans, LA 70118

(pp. 513-542 in Keen 1971) Taxa in **bold face type** are additions or changes.

Subfamily **Muricinae**

Genus **Murex**

Subgenus **Murex**, s.s.

975. *Murex (Murex) elenensis*
 976. *Murex (M.) recurvirostris*
 977. *Murex (M.) lividus*
 978. *Murex (M.) lividus tricornis*

Genus **Hexaplex**

Subgenus **Phyllonotus**

979. *Hexaplex (Phyllonotus) brassica*
 980. *Hexaplex (P.) erythrostomus*
Range: Gulf of California only.
 981. *Hexaplex (P.) regius*
 982. *Hexaplex (P.) peratus*

Subgenus **Muricanthus**

999. *Hexaplex (Muricanthus) ambiguus*
 1000. *Hexaplex (M.) callidinus*
 1001. *Hexaplex (M.) nigrinus*
 1002. *Hexaplex (M.) princeps*
 1003. *Hexaplex (M.) radix*

Genus **Paziella**

Subgenus **Paziella**, s.s.

1008. *Paziella (Paziella) galapagana*

Subgenus **Pazinotus** Vokes 1970

- *Paziella (Pazinotus) advenus* Poorman 1980

Genus **Pterynotus**

Subgenus **Purpurellus**

1010. *Pterynotus (Purpurellus) macleani*
 1011. *Pterynotus (P.) pinningeri*

Genus **Aspella**

1012. *Aspella hastula*
 1013. *Aspella pyramidalis*
 --- *Aspella pollux* Radwin & D'Attilio 1976

Genus **Dermomurex**

Subgenus **Dermomurex**, s.s.

1014. *Dermomurex (Dermomurex) indentata*
 1016. *Dermomurex (D.) obelus*

Subgenus **Takia** Kuroda 1953

1015. *Dermomurex (Takia) myrakeenae*

Subgenus **Gracilimurex**

1017. *Dermomurex (Gracilimurex) bakeri*

Subgenus **Trialatella**

1019. *Dermomurex (Trialatella) cunningghamiae*

Genus **Attiliosa**

1021. *Attiliosa nodulosa* A. Adams 1855 (an older name for *incompta*)

Genus **Calotrophon**

1023. *Calotrophon turritus*

Subfamily **Muricipsinae** Radwin & D'Attilio 1972

Genus **Homalocantha**

983. *Homalocantha multicristata*
 984. *Homalocantha oxyacantha*

Genus **Murexiella**

- 985 to 997. *Murexiella diomedaea, dipsacus, exigua, humilis, keenae, lappa, laurae, minuscula, perita, radicata, radwini, santarosana, vittata*
 --- *Murexiella mildredi* Poorman 1980

Genus **Murexsul**

998. *Murexsul jacquelineae*

Genus **Muricipsis**

- 1004 to 1007. *Muricipsis armatus, jaliscocensis, pauxillus, zeteki*
 --- *Muricipsis tulensis* Radwin & D'Attilio 1976

Genus **Maxwellia**

1018. *Maxwellia angemayerae*

Genus **Favartia**

Subgenus **Favartia**, s.s.

1028. *Favartia (Favartia) incisa*
 1029. *Favartia (F.) peasei (F. poorman* Radwin & D'Attilio 1976 is a synonym)

Subgenus **Caribiella** Perrilliat Montoya 1972

1027. *Favartia (Caribiella) erosa*
 --- *Favartia (C.) purdyae* Vokes & D'Attilio 1980

Genus **Acanthotrophon**

- 1041 to 1043. *Acanthotrophon carduus, sentus, sorensoni*

Subfamily **Ocenebrinae**

Genus **Ocenebra**

1032. *Ocenebra fontainei*
 1033. *Ocenebra lugubris*

Genus **Ceratostoma**

1034. *Ceratostoma monoceros*
 1035. *Ceratostoma unicorn*

Genus **Pteropurpura**

Subgenus **Pteropurpura**, s.s.

1036. *Pteropurpura (Pteropurpura) erinaceoides*
 1037. *Pteropurpura (P.) centrifuga*
 1038. *Pteropurpura (P.) deroyana*

Subgenus **Calcitrapessa**

1009. *Pteropurpura (Calcitrapessa) leeana*

Genus **Pterorytis**

1039. *Pterorytis hamatus*

Genus *Eupleura*

1024 to 1026. *Eupleura muriciformis*, *nitida*, *pectinata*

Genus *Trachypollia* Woodring 1928

1093. *Trachypollia lugubris*

Subfamily Ergalataxinae Kuroda, Habe, and Oyama 1971

Genus *Bizetiella* Radwin & D'Attilio 1972

1020. *Bizetiella carmen*

Bizetiella micaela Radwin & D'Attilio 1972

Bizetiella shaskyi Radwin & D'Attilio 1972

Genus *Pascula* Dall 1908

1022. *Pascula rufonotata*

1092. *Pascula ferruginosa*

Genus *Phyllocoma*

1030. *Phyllocoma scalariformis*

Genus *Ergalatax* Iredale 1931

1031. *Ergalatax buxeus*

Genus *Vitularia*

1040. *Vitularia salebrosa*

Genus *Xanthochorus*

1097. *Xanthochorus broderipii*

Subfamily Trophoninae

Genus *Trophonopsis*

1047. *Trophonopsis panamensis*

— *Trophonopsis lorenzoensis* Durham 1942

— *Trophonopsis diezi* Durham 1942

— *Trophonopsis hubbsi* Rokep 1972

(*Austrotrophon* and *Zacatrophon* are members of the Thaididae)

Subfamily Typhinae

(no changes at this time)

PANAMIC-PACIFIC CANCELLARIIDAE

An Update

Richard E. Petit

Research Associate

Department of Invertebrate Zoology

Smithsonian Institution

Washington, D.C. 20560

New distributional information of many Panamic-Pacific Cancellariidae comes from collecting recently done primarily by Dr. Donald Shasky and Mr. & Mrs. Paul Skoglund.

The taxon *Cancellaria peruviana* Strong 1954 is a probable synonym of *C. undulata* Sowerby 1848, and is not Panamic. *Cancellaria emydís* Dall & Ochsner 1928

and *C. gemmulata* Sowerby 1832 thought to be the same by Keen (1971) are considered separate species. *Cancellaria corrosa* Reeve 1856 is reported for the first time since 1887, and is a Panamic-Pacific species occurring off the coast of Mexico. A species of *Cancellaria* believed to be undescribed occurs from Mexico to Ecuador. *Agatrix* should be treated as a full genus and not as a subgenus of *Cancellaria*. *Cancellaria crenata* Hinds 1843 is here considered to be a junior synonym of *C. indentata* Sowerby 1832.

The genus-level taxon *Panarona* Petit 1975 is unnecessary, and it is a junior synonym of *Narona* H. & A. Adams 1854. The genus-level taxa *Narona* and *Hertleinia* are correctly used in Keen (1971).

The species referred to *Ovilia* by Keen are here considered to belong to *Massyla*. *Ovilia* does not occur in the Panamic-Pacific area. *Cancellaria cumingiana* Petit de la Saussaye 1844 may be a junior synonym of *C. obtusa* Deshayes 1830.

Cancellaria (Sveltia) gladiator Petit 1975, found off the Galapagos Islands, is added to the list of Panamic cancellariids. *Trigonostoma pygmaeum* (C.B. Adams 1852) is a junior synonym of *T. goniostoma* (Sowerby 1832). *Trigonostoma tuberculosum* (Sowerby 1832) and *T. bullatum* (Sowerby 1832) are probable synonyms. If they are the same the name *Trigonostoma tuberculosum* (Sowerby) must take precedence.

CONIDAE — Update

James H. McLean

Malacology Section

Los Angeles County Museum of Natural History

Los Angeles, CA 90007

[no abstract submitted]

NUDIBRANCHIA UPDATE IN TROPICAL WEST AMERICA

David K. Mulliner

Associate, Department of Invertebrate Zoology

San Diego Natural History Museum

San Diego, CA 92112

There are 68 species of nudibranchs listed in Keen (1971); an additional 14 were added to the list by Keen & Coan (1975). Since that publication 12 new species have been described. Of the original 68 species, one has been placed in synonymy, and two have been removed from the list as not found in tropical west America.

The 14 species of nudibranchs added to Keen (1971) by Keen & Coan (1975) are:

Aldia sanguinea (Cooper 1863) a range extension from southern California (Ferreira & Bertsch 1975)
Platydoris carolynae Mulliner & Sphon 1974
Chromodoris baumannii Bertsch 1970
C. marislae Bertsch 1973
Felimidia sphoni Marcus 1971
Hypselodoris agassizii Bergh 1894, reinstated by Sphon (1971)
Thorunna lapislazuli Bertsch & Ferreira 1974
Laila jansii Bertsch & Ferreira 1974
Flabellina stohleri Bertsch & Ferreira 1974
Coryphellina rubrolineata O'Donoghue 1929, in the Panamic province (Marcus & Marcus 1970)
Eubranthus rusticus Marcus 1961, in the Gulf of California, Mexico (Robilliard 1971)
Aeolidiella takanosinensis Baba 1930, in the Gulf of California, Mexico (Ferreira & Bertsch 1975)
Limenadra nodosa Haefelfinger & Stamm 1958, in the Gulf of California (Bertsch 1972)
Phidiana lasrucensis Bertsch & Ferreira 1974

The 12 species to be added to the updated material from 1975 are:

Chromodoris antoni Bertsch 1976
C. galexorum Bertsch 1978
Sclerodoris tanya (Marcus 1971), genus changed from *Doris* to *Sclerodoris* Bertsch 1981
Anisodoris tesellata Bergh 1898, left out of Keen (1971)
Peltadoris nyrtia Orta LLera 1981
Doriopsis viridis Pease 1861, in the Gulf of California (Bertsch 1971)
Tambja eliora (Marcus & Marcus 1967), genus changed from *Nembrotha* to *Tambja* Farmer 1978
T. abdere Farmer 1978
T. fusca Farmer 1978
T. mullinerii Farmer 1978
Roboastrea tigris Farmer 1978
Crosslandia daedali Poorman & Mulliner 1981
Bornella sarape Bertsch 1981

AN UPDATE OF MOLLUSKS WITH INDO-PACIFIC FAUNAL AFFINITIES IN THE TROPICAL EASTERN PACIFIC

Donald R. Shasky

Research Associate - Malacology Section
Los Angeles County Museum of Natural History
Los Angeles, CA 90007

The following species are added to the list of species found in both the tropical eastern Pacific and Indo-Pacific faunal provinces:

Bizetiella shaskyi (Radwin & D'Attilio 1972) collected on Moorea, French Polynesia.

Kernia maculosa (Pease 1862) collected on Isla Taboga, Panama.

Dr. Eveline Marcus has synonymized *Ascobulla ulla* from Brazil, and *A. californica* from the Gulf of California, with *A. japonica* from Japan. *Ascobulla japonica* has been taken at Isla La Plata, Ecuador.

The Indo-Pacific *Pseudocypraea adamsonii* (Sowerby), previously known from the Galapagos Islands, is reported from the continental shelf at Isla La Plata, Ecuador.

MOLLUSCAN POPULATIONS AT BAHIA SAN CARLOS, SONORA, MEXICO

Forrest L. Poorman and Leroy H. Poorman

15300 Magnolia Street, No. 55
Westminster, CA 92683

A study of the molluscan species in a rectangle 3 miles by 4 miles located at Bahia San Carlos, Sonora, Mexico, has been conducted for the past 29 years. Methods include both intertidal collecting and small boat dredging with more than 4000 dredging runs. Collecting records indicate that nearly 1000 species have been taken in the rectangle with another 200 minute species not yet identified. Seven newly described species have come from the study area. Nineteen new distributional records are reported. Observations of changing habitats and populations are detailed in terms of weather, pollution, seismic activity, and over collecting by commercial interests.

A STUDY OF THE ECOLOGY OF *Turritella gonostoma* LIVING IN THE GULF OF CALIFORNIA, MEXICO

Donna Vaughan

California State University
Northridge, CA 91324

Two winter populations of *Turritella gonostoma* (Valenciennes 1832) were found in the Gulf of California in brackish water near the mouth of the Mulege River, Baja California Sur, Mexico. One population consisted of 74 individuals in an area 50 cm by 75 cm in 2.2 m of water. The second population consisted of scattered clusters of 1 to 5 individuals located in water as shallow as 1.5 m, water temperature was 17°C.

Living position is typically on or just within the coarse sand substrate except for "storm" position, in which the body whorl is held above the ocean floor.

Orientation of the shells of living *T. gonostoma* is random, but shells occupied by hermit crabs are oriented parallel to the current direction. Trails are quickly destroyed by wave action.

In addition to *in situ* observations, aquarium studies of 54 individuals were monitored for a period of 4 months. Detrital feeding was observed. Movement patterns were mapped demonstrating that *T. gonostoma* handles its long shell with ease. General behavior patterns were observed that indicate a preference for highly oxygenated waters and a possibility that *T. gonostoma* may be a nocturnal feeder.

OBSERVATIONS OF LIVING

Caecum crebricinctum

Bertram C. Draper

Museum Associate - Malacology Section
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Five living specimens of *Caecum crebricinctum* (Carpenter 1864) were provided to me by Roger Evans, a scuba diver. I kept them in sea water in my refrigerator for more than one month, observing them intermittently during this period as they became active each time the water they were in was warmed. My observations were made with my binocular microscope at 30 and 60 power, with lighting from above and below. I observed that their tentacles had rather rigid setae at their tips and rows of tiny motile cilia along either side. These motile cilia moved with a pulsating motion. Those along the outer edges pulse toward the shell while the inner cilia move away from it. Water thus flows into and out of the shell, inside of which it flows through a gill between the upper part of the body and the mantle.

Placing a black rock in the clear plastic dish, one *Caecum* attempted to crawl to it. However the mucous path it tried to lay on the plastic would not hold, so the *Caecum* then retracted its body, pushed its operculum forward about one millimeter and then snapped it back in, which moved its shell forward. Repeating this action it reached the rock after several jumps. As it crawled onto the rock its buccal pouch was visible moving forward into its snout as an orange mass. The mouth at the end of the snout opened widely and the radula extended into the mouth with a rasping motion against the rock after which it retracted into the buccal pouch and the entire buccal mass moved back into the body.

Photos were taken of the animals while extended and drawings made of the cilia and water flow. Later a radula was photographed in both its retracted and extended positions. The radula of *Caecum crebricinctum* is taenioglossate with strong marginal teeth that meet at the center of the radular ribbon with little evidence of any rachidian tooth which is typical of the genus *Caecum*.

LIMPETS FROM THE HYDROTHERMAL VENTS AT THE GALAPAGOS RIFT AND THE RIFT AT 21 DEGREES NORTH

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[no abstract submitted]

LATE CENOZOIC MARINE INVERTEBRATE PALEONTOLOGY OF THE GALAPAGOS ISLANDS

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A recent paleontological expedition to the Galapagos Islands during February of 1982 visited eight main islands on which fossil deposits were reported. The basis of our interpretations is founded on a systematic and thorough program of field sampling conducted during two weeks travel amongst the islands. Marine fossils were collected from numerous and varied deposits such as: upraised beaches, terrace deposits, beach rock, limestones and sandstones interbedded with basalts, and scattered fossils embedded in tuff cones. The latter, from Cerro Gallina and a portion of Cerro Colorado on Santa Cruz Island, is probably the most paleontologically interesting setting in the Galapagos. This volcanic deposit presents a good example of a little-known and poorly-understood mechanism of fossilization.

Almost no two deposits were alike, making an archipelago-wide stratigraphic correlation unlikely. Ages of the deposits range from possibly Late Pliocene through Holocene.

A different evolutionary pattern for invertebrate fossils of these islands (in contrast to the well known terrestrial biota) has been demonstrated using: 1) a literature review, 2) field work, and 3) comparative morphological analysis of newly and previously collected museum specimens (both Recent and fossil). The pre-

sently available marine invertebrate fossil evidence does not support the scenario of rapid speciation and adaptive radiation frequently cited for terrestrial organisms in the Galapagos. We present two possible mechanisms that can be used in support of the hypothesis that evolution of the marine invertebrate fauna has proceeded at a slower rate: planktonic larval dispersal by oceanic currents (and the resulting inferred genetic exchange) or intrinsically slower rates of evolutionary change. These two mechanisms are not necessarily mutually exclusive. Invoking the larval dispersal mechanism, a biogeographic implication (drawn from this different evolutionary rate) is the widespread distribution of taxa throughout the Panamic province during late Cenozoic time.

Also participating in the expedition were Lois J. Pitt, Carole S. Hickman, and Jere H. Lipps. We thank the Ecuadorian government, the Galapagos National Park Service, and the Charles Darwin Research Station for making this research possible.

ON LINNAEUS' BOOKSHELF

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Linnaeus' "Systema Naturae" (1758) cited some forty works that he had consulted in his review of genera in Mollusca. The oldest of these was little more than 200 years old, for book-printing, especially of books needing illustration, was only getting started. Most of the works he cited were published after the year 1700, as printers became more skilled. Those whose work was most often mentioned by Linnaeus were the English naturalist Martin Lister; an Italian, Nicolas Gualtieri; and a Dutch clerical employee, George Rumphius.

Linnaeus' great accomplishment was his binomial system of naming: each recognizably separate form is given a unique name consisting of a generic term and a specific term. This combination is applied to this one form or species alone and to no other. Linnaeus also demonstrated the usefulness of brief but distinctive descriptions, and he tried also to cite good illustrations, so that the reader could visualize the species being discussed.

EAST IS EAST, ETC., ETC.

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On the occasion of the 15th anniversary of the Western Society of Malacologists, a short summary of the founding meeting was given, including slides showing the founding members at work deciding on the principles of the new society.

THE DISTRIBUTIONAL ECOLOGY OF MOLLUSCS ACROSS THE CONTINENTAL SHELF OF OREGON

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Bivalve and gastropod molluscs were quantitatively sampled off Coos Bay, Oregon at depths ranging from 22 to 116 meters. Three sites at different depths were chosen to describe the fauna across the continental shelf. Twenty-five box core samples (0.1 m²) were taken at each site during each season in 1981. Sediment samples were also taken and analyzed for percent sand, silt and clay.

The shallow site (22-36 m) exhibited a homogenous sediment structure of 99 to 100% sand. Molluscan species richness and density were very low. Only seven mollusc species were found with *Olivella pycna* (Berry, 1935), *O. baetica* Carpenter, 1864 and *O. biplicata* (Sowerby, 1825) constituting 77% of the total mollusc numbers. Densities of molluscs were approximately 300/m².

The intermediate site (56-74 m) had a sediment gradient across the study area with an increase to 15% silt and clay at the deepest stations. Molluscan density and species richness were greatly increased when compared to the shallow site. Mean densities were 800/m². Eighteen gastropod and twenty-four bivalve species were encountered. *Axinopsida serricata* (Carpenter, 1864) was the numerically dominant bivalve and *Mitrella gouldi* (Carpenter, 1856) the numerically dominant gastropod.

At the deep site (96-116 m) sand dropped down to 50% with 40% silt and 10% clay. Species richness was comparable to the intermediate site with 22 gastropod and 24 bivalve species. Mollusc densities were greatly increased to 1,400/m². *A. serricata* and *M. gouldi* were again the numerically dominant molluscs in their respective classes. Protobranch, deposit feeding bivalves also increased at this site, notably *Acila castrensis* (Hinds, 1843), *Nucula tenuis* Montagu, 1808 and *Yoldia seiscurata* Dall, 1897.

A multivariate analysis of variance (MANOVA) was used to compare species composition and density between the three sites. MANOVA results indicated significant differences between the sites in both species composition and density. The large shift in sediment structure and degree of wave activity appear to be the major factors influencing these differences in molluscan distribution.

**THE DISTRIBUTION OF *Diplodonta Orbellus*
(GOULD 1851) AND A DIAGNOSIS OF
Diplodonta Subquadrata (CARPENTER 1856)
(BIVALVIA: UNGULINIDAE)**

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In studying species of the genus *Diplodonta* Bronn 1831, from San Felipe, Baja California, Mexico, we have found conflicting information relating to the geographical distribution of *Diplodonta orbellus* (Gould 1851). Clarification of the species *D. subquadrata* (Carpenter 1856) became necessary in order to determine its morphology and distribution relative to *D. orbellus*. *Diplodonta suprema* Olsson 1961 was found to be a junior synonym of *D. subquadrata*.

**GEOGRAPHIC UNCERTAINTIES IN THE
WEST AMERICAN DONACIDAE**

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It is sometimes difficult to make simple, accurate statements about the distributions of species. On the west American coast there are often northern and southern records that represent different degrees of probability, possibility, or undoubted error. Problems that give rise to these uncertainties include:

- (1) Incorrect type localities.
- (2) Incorrect published records based on probably misidentified specimens no longer available for study.
- (3) Records from unlikely places based on material not in any present day collections.
- (4) Material in accessible collections from stations distant from the rest of the species' distribution, the interpretation of which depends on:
 - (a) The reliability of the locality data, including any demonstrable errors;
 - (b) The size of the gap between reliable stations and the problematical lot;
 - (c) how well intermediate stations have been studied;
 - (d) The habitat at the problematical stations; and
 - (e) the appearance of the specimens.

- (5) Larval settlement in years with unusual current or temperature conditions.
- (6) Introductions by man.

Examples from the Donacidae illustrate each of these problems except the last.

SEM STUDIES OF *Cypraea* RADULAE II

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High resolution SEM photographs show that differences between radular patterns are sufficient to distinguish among many species of *Cypraea*, but intrapopulation differences can be large enough to prevent species identification in some cases. If two radulae are nearly indistinguishable under SEM there is good cause to think that they are from the same species. For example, the radulae of *Cypraea semiplota* Mighels 1845 and *C. annae* Roberts 1869, often regarded as separate taxa, are indistinguishable. *Cypraea annettae* Dall 1909 and *Zonaria aequinoctialis* Schilder 1933 have practically identical teeth, but tooth placement on the radula ribbon is different enough to suggest that they are different species.

It is well to keep in mind that species-specific radular patterns have not been demonstrated throughout the genus *Cypraea*.

THE CANCELLARIID RADULA

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The neogastropod suborder Nematoglossa, Olsson 1970, forms a group noted for their unique radulae. Over 150 radulae from 35 species of cancellariids were examined using phase contrast and interference color photomicroscopy as well as scanning electron microscopy.

The radular apparatus includes a transparent outer sheath, an inner sheath that surrounds all but the anterior-most part of the subradular membrane, and the long, blade-like teeth that attach to the dorsal surface of the subradular membrane in a formula of 0-0-1-0-0. The lateral and marginal teeth have been lost; the central tooth has been highly modified. The central teeth are about $1000\ \mu$ in length and $35\ \mu$ wide at the base; they taper slightly distally and are about $10\ \mu$ wide at the tip. Medially within the inner sheath, the teeth are divided into anteriorly and posteriorly directed sets. About 100-150 μ from the distal tip, the individual teeth become folded in half, one tooth folded over the next. The distal tip of the teeth have about 6 small projections of about $1\ \mu$ in length on each side, emanating from a small flap of chiton. The anterior set is folded one outside the next so that the projections are exposed in a battery. The posterior set is folded one inside the next so that the projections are in the envelope fold of the next tooth.

TAXONOMIC PROBLEMS OF "*Cancellaria*" *io* DALL

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The radula of "*Cancellaria*" *io* Dall 1896, is markedly different from all other tropical species studied. In all other species studied, the radular filaments are attached to the dorsal surface of the subradular membrane, all of which are enclosed by the inner sheath. In "*Cancellaria*" *io* the radular filaments attach directly to the ventral surface of the inner sheath. It is probable that the subradular membrane has become fused to the inner sheath.

Because this radular morphology is so different from other tropical species and because this radular morphology is shared with the temperate "*Cancellaria*" *crawfordiana* Dall 1891, along with several shell characters, the generic assignment of these two species should be *Crawfordina* Dall 1919.

FIELD OBSERVATIONS OF THE BEHAVIOR OF *Sepia latimanus*

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Sepia latimanus displays a variety of colorings, postures, and behavior when interacting with another individual. Males express the greater variety of patterns including: the upward v-curl, the zebra, the umbrella, the yellow light, and various courting postures and colorings. The less elaborate postures, movements, and colorings of the female nevertheless appear to convey information to other males, females, and possibly to predators.

Unhatched as well as newly hatched *Sepia* employ a variety of color patterns and postures such as a semi-upward v-curl, a lifting of arms in an exaggerated cone shape, propulsion, and releasing of ink.

Male *Sepia latimanus* return on consecutive years to a specific area to compete for females which select adjacent dead *Lobophyllia* coral colonies for egg deposition. *Sepia latimanus* gather for reproduction in shallow (18-30 m) waters during January through May. As the females come from deeper water toward dead *Lobophyllia* coral colonies to deposit eggs, they are intercepted by males positioned at their own limestone mound along the margin of the reef slope. Because of their advantageous location larger males normally gain possession of the female as she arrives, sometimes challenging the male already escorting the female.

When the female is receptive, she mates with the male nearest to her. Repeated copulation with different males was observed throughout the reproductive period of each female.

After a female deposits fertile eggs, copulation with a waiting male follows. She begins depositing fertile eggs again after 15 to 20 minutes. Identifiable females deposited fertile eggs during each of the 30 days that they were present in the observation area.

The critical factor determining the location of the gathering is crevices deep and narrow enough for egg placement. Eggs average 1.8 cm to 2 cm in diameter, so they are retained inside the coral when they become detached during development. Hatching occurs 38 to 40 days after deposition.

MURICIDAE (MOLLUSCA: GASTROPODA) OF THE ESMERALDAS FORMATION, NORTHWESTERN ECUADOR

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Inasmuch as the Tertiary "Atrato Strait" of Columbia is assumed to have been the largest and most long-lasting trans-American seaway, a study of the muricid gastropods of the Pliocene Esmeraldas Formation of Ecuador was undertaken to compare relationships with the contemporaneous Caribbean fauna. The results show

much less correlation with the Caribbean fauna than anticipated; of the 17 species studied the greatest number in common with any fauna proved to be eight that are still living on the coast of West America. But, of these, four no longer occur in Ecuador (one is confined to the Galapagos, one to California, and two do not extend south of Panama). Three species are very near, if not identical to, living West Atlantic forms and one seems to be a Mediterranean species. In terms of presumed ancestry, nine of the 17 species have unmistakable Caribbean ancestors, and an additional three are world-wide Tethyan genera that may or may not have come from the Caribbean. However, three are northern California-Japanese in relationship and two probably came directly from West Africa.

LINEAGES AND CONVERGENCE IN THE TYPHINAE (MURICIDAE)

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It is proposed here that four genera of the Typhinae—*Pterotyphis*, *Tripterotyphis*, *Cinclidotyphis*, and *Protyphis*—be considered a convergent lineage bearing in common with the remaining supraspecific taxa of this subfamily only the possession of a tube. Both shell and radular characters sustain this proposal. Most typhine or typhine-like genera arose early in the Tertiary, probably from a number of earlier muricine species.

SOME PANAMIC-CARIBBEAN MURICID COGNATES

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Slides of a number of species of what appear to be cognate Muricidae of the Caribbean and Panamic faunas were shown.

THE REPRODUCTION AND TAXONOMY OF A WEST COAST CHITON GENUS

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Based upon electrophoretic evidence, reproductive attributes, egg-hull sculpturing, and computer analysis of shell plate shape, new species have been added to the chiton genus *Lepidochitona* Gray 1821 (= *Cyanoplax* Pilsbry 1892) on the west coast of the USA. Supported by this taxonomic revision, a study has been made using these small intertidal chitons as a natural system for contrasting the consequences of two alternative modes of reproduction.

Two species of chitons brood their young in central California. These are *Lepidochitona* n. sp. Earnisse (in prep.), and *L. thomasi* (Pilsbry 1898, formerly placed in the genus *Nuttallina*). In addition, a population of brooders recently discovered on San Jaun Island in Washington may be an undescribed species, or a new subspecies of *L. thomasi*.

Three species of *Lepidochitona* which free spawn their eggs have also been examined. These include two relatively common species, *L. hartwegii* (Carpenter 1855) and *L. dentiens* (Gould 1846). A third free spawning species, represented by populations presently under investigation in Santa Cruz and San Mateo Counties in central California, is in some respects similar to the southern California species *L. keepiana* Berry 1948, but may also be a new species.

Each of these species of *Lepidochitona* has been analyzed with starch gel electrophoresis and have distinct, non-overlapping banding patterns for specific enzymes. It is possible to demonstrate with simple genetic hypotheses, that these species are not interbreeding, even though they are living sympatrically. This method of estimating the genetic exchange between species is especially useful in a group such as chitons, where there is a large amount of phenotypic variation within each species.

The unique egg hull sculpturing of each species, as examined with SEM is a reliable morphological character useful for distinguishing members of the genus, as is the stage of larval hatching from the egg capsule. The shape of a single shell plate (no. 5) has also been analyzed for all these species, using Wilks' method of morphometric analysis, and is helpful in discriminating between species. This method is especially powerful in comparisons of intraspecific versus interspecific variation.

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Museum der Naturkunde
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THE WESTERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT



Seattle, Washington
7-13 August, 1983

Volume 16

The Western Society of Malacologists

Annual Report

Volume 16

Seattle, Washington

7-13 August, 1983

Joint meeting with

The American Malacological Union

Issued: **MAY 31 1984**

Editorial Board, 1983-1984

Steven J. Long, Editor

Hans W. Bertsch

Eugene V. Coan

George L. Kennedy

The **Annual Report** of the Western Society of Malacologists is based on its yearly meeting. Distribution of the **Annual Report** is free to regular and student members who are, at the time of issue, in good standing. Membership dues are \$7.50 and \$3.00 for students. Others of a regular member's family may join for an additional \$1.00; each family receives only one **Annual Report**.

The Western Society of Malacologists has issued two **Occasional Papers**—No. 1, “‘Sea Shells of Tropical West America’: Additions and Corrections to 1975” by Myra Keen & Eugene Coan; and No. 2, “A Catalogue of Collations of Works of Malacological Importance” by George E. Radwin & Eugene Coan. Each was priced at \$2.50. The first is now out of print; the second is still available.

Correspondence regarding membership and orders for additional or back issues of the **Annual Report** or the **Occasional Papers** should be addressed to the current W.S.M. Treasurer, Mrs. Margaret Mulliner, 5283 Vickie Drive, San Diego, CA 92109.

When full-length papers are included in the **Annual Report** or **Occasional Papers** they are reviewed by two members of the Editorial Board in addition to the Editor.

NOTICE OF 17th ANNUAL MEETING THE WESTERN SOCIETY OF MALACOLOGISTS IN 1984

The 17th Annual Meeting of the Western Society of Malacologists will be held on the campus of the University of California at Santa Cruz on August 16-19, 1984. Emphasis of this year's meeting will be on the Natural History of Marine Mollusks of the Eastern Pacific Ocean. In addition to the regular program of contributed papers, several special symposia are planned, including ones on Nudibranchs, Parasitic Mollusks, and Paleoecology of Fossil Mollusks. The meeting will also feature slide shows, exhibits, a shell and book auction, and field trips. All persons interested in west American mollusks should plan to attend this meeting. For further information, please contact WSM Secretary: Dr. F. G. Hochberg, Department of Invertebrate Zoology, Museum of Natural History, 2559 Puesta del Sol Road, Santa Barbara, CA 93105.

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MINUTES, EXECUTIVE BOARD WESTERN SOCIETY OF MALACOLOGISTS

9 AUGUST 1983

Present: Draper, Hochberg, Kennedy, Lindberg, Mulliner, Shasky, Skoglund, Terry-Smith.

The meeting was called to order by President Dave Lindberg at 7:50 p.m.

Secretary's Report

President Lindberg appointed Eric Hochberg as Acting Secretary in Katherine Stewart's absence.

Minutes from the 1982 Board Meeting were read by Eric Hochberg.

MSP to approve minutes of the 1982 Executive Board Meeting.

Treasurer's Report

Margaret Mulliner presented the Treasurer's Report. MSP to accept Treasurer's Report as presented.

1983-84 Officers

Chairman of the Nominating Committee, Donald Shasky, proposed the following slate of officers:

President	George L. Kennedy
1st Vice President	William Pitt
2nd Vice President	Carole Hertz
Secretary	F. G. Hochberg
Treasurer	Margaret Mulliner
Members-at-Large	Joyce Gemmell, Robert Koch

MSP to accept slate as presented.

1984 Annual Meeting

George Kennedy discussed possibilities for the 1984 meeting. Eric Hochberg and George Kennedy are to explore the possibility of hosting the meeting in Santa Barbara.

MSP to provisionally designate Santa Barbara as the site for the 1984 meeting.

George Kennedy was directed to phone UCSB to explore possible dates in late August before the Business Meeting on Thursday. The Board will be notified within four weeks to confirm meeting location and dates. Two UCSB campus contacts were suggested: James Valentine (Department of Geology) and Armand Kuris (Department of Biological Sciences).

OTHER BUSINESS

1. Advisory Board

Past President Don Shasky proposed a change in the By-Laws to place **all** past Presidents, not just the past three Presidents, on the Executive Board as voting members. In the absence of a motion it was informally agreed to establish an Advisory Board with all past Presidents helping to actively advise the Executive Board. In the future all past Presidents will be invited to attend the Executive Board Meeting.

Acting Secretary Eric Hochberg will send minutes of both the Executive Board and Annual Business meetings to all Board members and past Presidents by 9 September. In the future an agenda will be prepared by the Secretary and mailed in advance to all Board members and past Presidents.

2. Display Cases

President Dave Lindberg mentioned that five large wood and glass display cases have been stored at the Asilomar Convention Center since 1976. Bert Draper said that these cases were obtained originally by Rudy Stohler from the University of California, Berkeley, and were used at the meeting held in Asilomar in 1976. Eugene Coan has presented the President with a check for \$100 for purchase of a case for the Sierra Club Library. In exchange for transporting the cases back to Berkeley the Sierra Club was given a second case. Discussion ensued about what to do with the remaining cases.

MSP that President dispose of the remaining three cases in a way most beneficial to the WSM.

3. Student Grants

Judy Terry-Smith, acting for the Student Grant Committee, reported that the Committee received and reviewed 27 proposals and awarded two grants:

First Place WSM Scholarship (\$600): David Myers (CSUF)

Second Place SMS Scholarship (\$500): Alan Hebert (MLML).

All present agreed they wanted this program to continue. Judy will ask Vida Kenk to develop a flyer about the program which will be included with the mailing of the Dues notices. The Treasurer was asked to add a **voluntary donation** line item on the Dues form to encourage members to contribute to this fund.

The President asked to be able to review/proofread all forms, notices and other mailings of the Society in order to ensure that all items are included.

4. 1984 Annual Meeting

George Kennedy suggested that in order to draw amateurs and professionals together at the 1984 Annual Meeting the theme be the Natural History of Marine Mollusks.

Two State of the Art Symposia were suggested:

- Estuarine Mollusks (Wayne Sousa, Chris Onuf, etc.)
- Parasitic Mollusks (Anders Waren, Robert Robertson, etc.)

It was recommended that the symposia be organized as college level exploratory overviews, not as lectures on highly technical research subjects.

5. 1983 Annual Report

Steve Long will be asked to serve as Editor of the 1983 Annual Report and President Dave Lindberg will serve as Acting Editor. The 1983 Report will include reports by Secretary and Treasurer, group photo, abstracts of papers presented by WSM members and full length articles selected by the Editor.

MSP to allocate no more than \$1,500 for 300 copies of the 1983 Annual Report.

OTHER BUSINESS

1. Annual Report

Don Shasky asked why the 1982 Annual Report was delayed. President Lindberg reported that delays occurred at three levels:

- a. some materials were not received by Editor Mike Kellogg until December
- b. many abstracts needed editing
- c. confusions in billings and payments

In response to a question by Sandy Gardner concerning these delays it was stated that the past President is responsible for monitoring the Editor for his year and checking on the production progress for the Annual Report. In order to avoid future delays it was agreed to use an interim Treasurer's Report if necessary.

President Lindberg announced that the Editor for the 1983 Annual Report was Steve Long.

Eugene Coan recommended that the By-Laws be published in the 1983 Annual Report.

Vida Kenk asked whether abstracts of all papers presented by WSM members at the Seattle meeting would be published in the 1983 Annual Report. Tom Burch questioned whether the same abstracts should be published in both places. Jim McLean stated that his understanding as per the wording in the meeting announcement was that an abstract was to be submitted to *either* the WSM *or* the AMU. The matter was left to President Lindberg to decide.

President Lindberg announced that as a result of a recent AMU motion there will be a \$15 charge for all abstracts submitted to the AMU Bulletin. Reprints of abstracts can be ordered from the AMU Editor. All abstracts should be sent to the Editor (AMU or WSM) by 1 September.

2. Auction

President Lindberg reported that the AMU Shell Auction netted \$682, half of which, \$341, the WSM received.

3. Display Cases

President Lindberg reported that a check for \$100 was received from the Sierra Club for purchase of 1 of 5 old AMU-PD glass display cases which had been stored at Asilomar since 1976. A second case was donated to the Sierra Club for their efforts to transport all five cases to Berkeley where they are currently stored. After discussion, it was:

MSP to authorize President to dispose of the remaining three cases in a way most beneficial to WSM.

4. President Lindberg now presented the gavel to President elect George Kennedy. George Kennedy thanked Dave Lindberg for his efforts as President during the year.

5. 1984 Annual Meeting

President Kennedy reported that Santa Barbara was tentatively proposed as the 1984 meeting site in the Executive Board meeting. However, upon calling UCSB he found out that Santa Barbara has been designated as a Satellite City for the 1984 Olympics and, hence, is entirely booked for next summer. He then suggested hosting the meeting in the Bay Area or in Santa Cruz at UCSC. He will explore possibilities with a proposed date in mid-late August. The theme for the meeting will be "Natural History of Marine Mollusks".

A preliminary flyer announcing the meeting will be sent out with the 1982 Annual Report. Updated flyers will go out with the Dues notice and again with the 1983 Annual Report.

6. AMU Acknowledgement

In response to the excellent meetings it was:

MSP that Secretary elect Eric Hochberg write thank-you letters acknowledging the efforts of Dr. Alan Kohn and The Pacific Northwest Shell Club in organizing and hosting the joint meeting in Seattle.

7. Student Grants

Barry Roth asked if the WSM could provide a student grant each year if the money was available.

After discussion it was:

MS that the WSM match dollar for dollar all donations received toward the Student Grant Program. When the combined amount exceeds \$250 a student grant would be awarded.

Considerable discussion ensued on the complications of the motion as stated.

AMENDED and ACCEPTED to direct the President and Treasurer to explore the feasibility of committing the WSM to the above motion. MOTION FAILED.

8. There being no further business it was:

MSP to adjourn the 1983 Business Meeting.

The meeting was adjourned by President George Kennedy at 3:20 p.m.

Respectfully submitted: F. G. Hochberg
Secretary

Approved by: David Lindberg
President (1982-83)

TREASURER'S REPORT

Period Covering 7/31/1982 to 9/1/1983

Balance beginning of period				\$4920.26
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INCOME

Dues:				
1982 reg.	4 @ 7.50	\$ 30.00	\$ 30.00	
1983 reg.	149 @ 7.50	1117.50		
fam.	21 @ 1.00	21.00		
stud.	6 @ 3.00	18.00	1156.50	
1984 reg.	2 @ 7.50	15.00		
stud.	1 @ 3.00	3.00	18.00	1204.50
Publications				
Vol. 13	1 @ 7.50	7.50		
Vol. 14	1 @ 7.50	7.50	15.00	
Donations:				
Student Fund		139.56	139.56	
Interest on S/A				
		284.78	284.78	
Auction (8/10/83)				
		341.00	341.00	780.34
	Income			6905.10
	Expenses			2338.24
	Balance			\$4566.86

EXPENSES

Period covering 7/31/82 to 9/1/1983

Margaret Mulliner, Treasurer	\$ 111.98*	
Katherine Stewart, Secretary	31.67*	
COA dues	7.50	
AMU dues	17.00	
Secretary of State fees	2.50	
Student Grant	600.00	
Vida Ken (notices for Student grant)	105.96	
Annual Report 1982		
Typesetting	484.38	
Printing	745.50	
Postage, mailing	97.65*	
	100.00	
Historian (material for book and photo)	30.10*	
	4.00	
		\$2338.24

*Checks outstanding 9/1/1983

Secretary	2.12
Historian	30.10
Annual Report	97.65
Treasurer	11.90
	<u>141.77</u>

Margaret Mulliner, Treasurer





KEY TO WSM/AMU JOINT MEETING (SEATTLE, WASHINGTON, AUGUST, 1983) GROUP PHOTOGRAPH

- | | | |
|-----------------------|---------------------------|---------------------------|
| 1. Arthur J. Cain | 41. Elsie Messing | 80. ? Lucille Taylor |
| 2. Claude Morris | 42. Art Bogan | 81. Noorulah Babrazkai |
| 3. A. R. Palmer | 43. Dorothea Franzen | 82. Audrey Holliman |
| 4. Peter Hoover | 44. Leslie Newman | 83. Does Not Exist |
| 5. Alan Kabat | 45. Bowie Kotrla | 84. Liz Petit |
| 6. William Emerson | 46. Jane Topping | 85. Joseph Rosewater |
| 7. Matthew James | 47. Juliette Compitello | 86. M. Patricia Morse |
| 8. Daryl Foote | 48. Brad Lounsbury | 87. Ron Toll |
| 9. Joe Houbbrick | 49. Margaret Teskey | 88. Jennifer Plummer |
| 10. Dennis Willows | 50. Jane Deisler | 89. Geerat J. Vermeij |
| 11. Ray Hixon | 51. George M. Davis | 90. Terrance Gosliner |
| 12. F. G. Hochberg | 52. Mrs. William Lyons | 91. Mike Sweeney |
| 13. Jerry Landye | 53. Thomas A. Burch | 92. Judith Terry Smith |
| 14. Jim Quinn | 54. Donna Turgeon | 93. Clyde Roper |
| 15. James McLean | 55. Walter Miller | 94. Vida Kenk |
| 16. Harold D. Murray | 56. Fred Thompson | 95. Mrs. Walter Lowrey |
| 17. Herb Young | 57. Dick Reeder | 96. Constance Boone |
| 18. Tom Pulley | 58. H. Wayne Holliman | 97. Bert Draper |
| 19. Sally Bennett | 59. | 98. Billee Dillworth |
| 20. Stuart Lillico | 60. David K. Mulliner | 99. Sandra Gardner |
| 21. Bill Lyons | 61. Timothy Pearce | 100. Walter Moore |
| 22. Hugh Porter | 62. Mrs. Harold Harry | 101. Elaine Welty |
| 23. Don Shasky | 63. Patrick LaFollette | 102. Stephen Welty |
| 24. | 64. Robert Prezant | 103. Dorothy Beetle |
| 25. | 65. Lyle Walsh | 104. Charlotte Gorbunoff |
| 26. Raymond Neck | 66. Michael Hadfield | 105. Alex Gorbunoff |
| 27. Paul Scott | 67. David Lindberg | 106. Mrs. Rios |
| 28. Richard E. Petit | 68. Dave Jablonski | 107. Helen Lillico |
| 29. Harold Harry | 69. Paul Pointer | 108. Rose Killam |
| 30. | 70. Eugene Coan | 109. Mary Rosewater |
| 31. John Jenkinson | 71. Beatrice L. Burch | 110. Mrs. Ron Toll |
| 32. William Pratt | 72. Louise Kraemer | 111. Fred Sorenson |
| 33. Hollis Q. Boone | 73. Mrs. Donald Moore | 112. Myra Taylor |
| 34. Barry Roth | 74. Mrs. Ginne Jenneweine | 113. Melbourne R. Carrier |
| 35. George Kennedy | 75. Edith Abbott | 114. Robert Robertson |
| 36. Rose Burch | 76. Twila Bratcher | 115. Alan J. Kohn |
| 37. Donald Moore | 77. Patti Lounsbury | 116. Paul E. Jenneweine |
| 38. Margaret Mulliner | 78. Elsie Marshall | 117. George D. Buckley |
| 39. Sally Walker | 79. K. Elaine Hoagland | 118. William Bledsoe |
| 40. Walter Lowrey | | 119. E. deC. Rios |

WESTERN SHELL CLUBS

Chico Seashell Club

c/o Phyllis Slattery, SEC.
106 Terrace Drive
Chico, CA 95926
[meets twice a month, 2nd Wed 9:30 am in members' homes, and 4th Wed 7:30 pm at Pleasant Valley Recreation Center, North Avenue, Chico, CA]

Conchological Club of Southern California

c/o Malacology Section
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, CA 90007
[meets in Museum Lounge, 7:30 p.m., first Monday of each month, unless a holiday, then on Wednesday of same week]

Hawaiian Malacological Society

P.O. Box 10391
Honolulu, HI 96816
[meets first Wednesday of each month, 7:00 p.m., at First United Methodist Church, Victoria & Beretania Streets, Honolulu; December party at another location]

Houston Conchology Society

c/o Constance Boone
3706 Rice Boulevard
Houston, TX 77005
[meets fourth Wednesday of August, September, October, January, February, March, April, and May; third Wednesday of November, at the Houston Museum of Natural Science]

Monterey Peninsula Shell Club

Donna Fagan, secretary
4158 El Bosque Drive
Pebble Beach, CA 93953
[meets at the Allen Knight Maritime Museum, 550 Calle Principal, Monterey, California, on the third Tuesday of each month at 7:30 p.m. Programs and local collecting trips are planned monthly]

Northern California Malacozoological Club

121 Wild Horse Valley Drive
Novato, CA 94947
[meets third Thursday of each month at the California Academy of Sciences]

Oregon Society of Conchologists

Dr. Byron W. Travis
4324 NE 47th Avenue
Portland, OR 97218
[meets first Sunday of each month, 1:30 p.m., in private homes; announcements given in monthly paper or by card]

Pacific Northwest Shell Club, Inc.

c/o 15128 Sunwood Blvd.
Tukwila, WA 98188

Pacific Shell Club

c/o John Boyd
11813 Morning Ave.
Downey, CA 90241
[meets in Museum Lounge first Sunday of each month, 1:30 p.m., October through June]

San Diego Shell Club

c/o 3883 Mt. Blackburn Avenue
San Diego, CA 92111
[meets third Thursday of every month, Casa del Prado, Balboa Park]

Santa Barbara Malacological Society

P.O. Box 30191
Santa Barbara, CA 93105
[meets third Friday of every month, 7:30 p.m., Santa Barbara Museum of Natural History, 2559 Puesta del Sol]

Southwestern Malacological Society

c/o Mrs. Carol C. Skoglund
3846 E Highland Avenue
Phoenix, AZ 85015
[meets third Wednesdays, September through May, 7:30 p.m., Asbury United Methodist Church, 1601 West Indian School Road, in auxiliary rooms]

Yucaipa Shell Club

c/o Mousley Museum of Natural History
35308 Panorama Drive
Yucaipa, CA 92399
[meets third Sunday of every month except August, 2:00 p.m., in the Museum]

ABSTRACTS OF PAPERS PRESENTED TO THE ANNUAL MEETING

OPENING REMARKS AND WELCOME

Alan J. Kohn
Dept. of Zoology
University of Washington, Seattle, WA

SYMPOSIUM: MOLLUSCAN NERVOUS SYSTEMS AND BEHAVIOR

A. O. D. Willows, presiding
Dept. of Zoology
University of Washington, Seattle, WA

INTRODUCTORY REMARKS

A. O. D. Willows

GASTROPOD BEHAVIOR

Teresa E. Audesirk
Dept. of Biology
University of Colorado at Denver, Denver, CO

Gastropod behavior will be reviewed with emphasis on behaviors which are amenable to analysis at the neuronal level. Gastropod learning will be stressed.

HOW THE NERVOUS SYSTEM CONTROLS BEHAVIOR

Ken Lukowiak
Dept. of Medical Physiology, Faculty of Medicine
University of Calgary, Calgary, AB

This presentation will discuss the changes in normal activity which underlie alterations of behavior. Thus types of non-associative and associative learning as well as behavioral state will be discussed.

LIMAX LOGIC: BEHAVIORAL AND NEUROPHYSIOLOGICAL STUDIES OF THE CAPABILITIES OF THE *LIMAX* NERVOUS SYSTEM

Steven J. Wieland
Dept. of Biology
Princeton University, Princeton, NJ

Behavioral experiments have demonstrated higher-order learning processes in the feeding behavior of *Limax maximus*. Neurophysiological studies have revealed the learning ability of the isolated nervous system, and the roles of several transmitters within the feeding network.

IDENTIFIABLE NEURONS IN MOLLUSCAN NEUROBIOLOGY

Gerald Audesirk
Dept. of Biology
University of Colorado at Denver, Denver, CO

The presence of uniquely identifiable neurons in molluscan brains has made invaluable contributions to studies of neurobiology. The usefulness, criteria, and applications of identifiable neurons will be discussed, with particular emphasis on gastropod neurobiology.

A MOLLUSCAN NEUROPEPTIDE ACTS AT MULTIPLE SITES TO MODULATE FEEDING BEHAVIOR IN GASTROPODS

Philip Lloyd
Columbia Medical School, New York, NY

A neuropeptide (SCP sub-B) recently sequenced from *Aplysia* central nervous system, and neurons which contain this peptide, act centrally to enhance neuronal output from the buccal ganglia, and peripherally to enhance contractile activity of the gut and muscles of the buccal mass.

SYMPOSIUM: SUPPORT SERVICES IN MALACOLOGY

Clyde F. E. Roper, presiding
Dept. of Invertebrate Zoology
National Museum of Natural History, Washington, DC

ADMINISTERING A SHELL CLUB SCHOLARSHIP PROGRAM

Stuart Lillico
Honolulu, HI

Using donated funds, proceeds of shell auctions, and interest earned on assets, the Hawaiian Malacological Society has established a worldwide scholarship fund that distributes about U.S. \$5000 a year to advanced students of malacology. Finding qualified applicants is a problem.

COMPUTER AIDS TO CURATION OF MOLLUSC COLLECTIONS

Pat LaFollette
Los Angeles, CA

The pros and cons and methods for computerization of molluscan collection data.

COMPUTERIZATION OF TAXONOMIC CATALOGUES

Alan J. Kohn
Dept. of Zoology
University of Washington, Seattle, WA

A catalogue of published names in taxonomy is indispensable to the taxonomist. Microcomputers permit more efficient, less expensive catalogue production and provide several additional advantages over traditional publication.

A PROPOSED GENERALIZED MOLLUSCAN SHELL GROWTH MODEL: GASTROPOD MORPHOLOGY AND CONSTRUCTIONAL PATTERNS

Matthew J. James
Dept. of Paleontology
University of California, Berkeley, CA

Using gastropods as examples of complex constructional patterns, the model aids identification of temporal and spatial components of alteration in shell structure, ornamentation, and architecture.

PRINCIPLES PROPOSED FOR USE AS GUIDELINES IN THE ESTABLISHMENT OF A SYSTEM OF COMMON NAMES FOR AMERICAN MOLLUSCS

David H. Stansbery
Museum of Zoology
Ohio State University, Columbus, OH

It is anticipated that a set of generally accepted principles, used in selecting common names for mollusc species for the official A.M.U. list, will produce a readily acceptable list which will be efficient to use and have maximal stability over the years ahead.

SYMPOSIUM: MOLLUSCAN EXTINCTIONS IN THE GEOLOGIC PAST AND AT THE PRESENT TIME

Geerat J. Vermeij, presiding
Dept. of Zoology
University of Maryland, College Park, MD

INTRODUCTION

Geerat J. Vermeij

ON THE CRETACEOUS EXTINCTION OF THE AMMONITE CEPHALOPODS

Peter Ward
Dept. of Geology
University of California, Davis, CA

The ammonites were the most diverse group of cephalopods known from the fossil record. After a long evolutionary history, they underwent complete extinction at the end of the Cretaceous period. This extinction, however, was preceded by changes in shell morphology which can be interpreted to imply major habitat change, and possibly change in mode of life prior to the extinction event itself.

FAUNAL REPLACEMENT AND CAUSES OF POST-MIOCENE EXTINCTION OF PELECYPODS IN THE CHESAPEAKE BAY REGION OF MARYLAND

Brett W. Kent and Geerat J. Vermeij
Dept. of Zoology
University of Maryland, College Park, MD

Only 39% of subgenera of epifaunal and sand- and mud-burrowing pelecypods present in latest Miocene time in the Chesapeake Bay region of Maryland live today in shallow waters of the Virginian Province. Of 32 locally extinct subgenera, all occur south of Cape Hatteras and only one extends both north of Cape Cod and south of Cape Hatteras.

DIFFERENTIAL EXTINCTION IN TROPICAL AMERICAN MOLLUSCS: ENDEMICISM, SHELL ARCHITECTURE, AND THE PANAMA LAND BRIDGE

Geerat J. Vermeij and Edward J. Petuch
Dept. of Zoology
University of Maryland, College Park, MD

Uplift of the Central American isthmus during the Pliocene triggered a substantial impoverishment in the biota of tropical America. Extinction affected gastropods to a greater extent in the Caloosahatchian (36%) and Atlantic Gatunian (36%) regions than in the Pacific Gatunian area (15%).

MODERN MOLLUSCAN BIOGEOGRAPHIC PATTERNS AND THEIR SIGNIFICANCE FOR MASS EXTINCTION EVENTS

David Jablonski
Dept. of Geosciences
University of Arizona, Tucson, AZ

EXTINCTION IN HAWAIIAN ACHATINELLID TREE SNAILS

Michael G. Hadfield
Kewalo Marine Laboratory
University of Hawaii, Honolulu, HI

Hawaiian endemic tree snail species (family Achatinellidae) have been disappearing for at least 50 years. Primitive snail densities are compared with current ones, and intrinsic and extrinsic factors associated with extinction discussed.

CONTRIBUTED PAPERS: BIOLOGY AND PALEOBIOLOGY OF TROPICAL AND SUBTROPICAL MARINE MOLLUSCS

Elizabeth Nesbitt, presiding
California Academy of Sciences, San Francisco, CA

KIDNEY FUNCTION IN GIANT CLAMS

R. G. B. Reid
Dept. of Biology
University of Victoria, Victoria, BC

The hypertrophied kidneys of giant clams have a digestive function, and can process zooxanthellae and store toxic and unusable components in nephroliths.

A TAXONOMIC REVISION OF THE CRASSATELLINAE OF THE EASTERN PACIFIC WITH SOME COMMENTS ON THE BIOGEOGRAPHY OF THE PANAMA CONNECTION

Eugene Coan
Dept. of Invertebrate Biology and Paleontology
California Academy of Sciences, San Francisco, CA

The taxonomic status of the three Recent species of *Eucrassatella* has been completed, and several new synonymies have been made. This review has led to a consideration of the taxonomic treatment of related populations on the two coasts of Panama.

CHITON (MOLLUSCA: POLYPLACOPHORA) FAUNA OF THE U.S. SOUTH ATLANTIC SEABOARD

William G. Lyons
Florida Dept. of Natural Resources
Bureau of Marine Research, St. Petersburg, FL

Factors influencing distributions of 16 chiton species between Palm Beach County, FL, and Morehead City, NC, are discussed, and new species of *Hanleya* and *Chaetopleura* are diagnosed.

EULIMIDS PARASITIC ON HAWAIIAN ECHINODIS

**Anders Warén, Beatrice L. Burch,
and Thomas A. Burch**
Kailua, HI

Five new species of Eulimidae obtained from echinoids collected by scuba or dredging from 15 to 470 meters off Oahu, Hawaii are described briefly. Since the article naming the species has not been published, specific names will not be used.

A species of *Trochostylifer* was found in galls on the heavy dorsal spines of *Chondrocidaris gigantea* at depths of 15 to 25 meters. A second species of *Trochostylifer* was found in the galls on the test of the closely related echinoid, *Prionocidaris hawaiiensis* from a depth of seventy-two meters.

Two species that have been placed provisionally in the genus *Vitreolina* were found on the same two species of echinoids.

The fifth species of eulimid is in the genus *Pelseneeria* which was found on *Aspidodiadema hawaiiensis* dredged from 470 meters off Honolulu.

EULIMID INFESTATION RATES AROUND OCEANIC ISLANDS

Gustav Paulay
Dept. of Zoology
University of Washington, Seattle, WA

Eulimid gastropods parasitic on holothurians show increased incidence on the windward, down-current side of an isolated oceanic island.

DIET MIXING: HOW *CYPHOMA* GET THEIR SPOTS

Drew Harvell
Dept. of Zoology
University of Washington, Seattle, WA

Cyphoma gibbosum prey exclusively on gogonacean coelenterates throughout the Caribbean Sea. An ontogenetic shift in foraging behavior may explain juvenile-adult color changes and patterns of prey injury.

THE *CALLIOSTOMA PULCHRUM* SPECIES COMPLEX IN THE NORTHERN WESTERN ATLANTIC

James F. Quinn, Jr.

Florida Dept. of Natural Resources
Bureau of Marine Research, St. Petersburg, FL

Apparent intergrades in shell morphologies between *Calliostoma pulchrum* (C. B. Adams, 1850) and *C. roseolum* Dall, 1881, prompted a reexamination of the *C. pulchrum* species complex within the northern Western Atlantic. Five distinct forms were evaluated: *C. pulchrum* (Caribbean), *C. roseolum* (southeastern U.S.), *C. apicinum* Dall, 1881, *C. roseolum* (Barbados), *C. veliei* Pillsbry, 1900 (southeastern U.S.), and a unnamed form (Texas).

UPDATE ON MOLLUSKS WITH INDO-PACIFIC FAUNAL AFFINITIES IN THE TROPICAL EASTERN PACIFIC — II

Donald R. Shasky
Redlands, CA

This paper cites new Indo-Pacific records from Cocos Island. It is located approximately 300 miles south by southwest of Puntarenas, Costa Rica and is the largest uninhabited island in the world. It is about 20 square miles. Its annual rainfall is 22 feet (7000 mm). It has 200 waterfalls and a number of bays and inlets. In April the water temperature at all depths was 85°F.

The following seven species had not been previously recorded in the Eastern Pacific.

1. *Viriola abbotti* (Baker & Spicer, 1935)
This was described from Samoa and subsequently reported living in Hawaii by Dr. E. Alison Kay.
2. *Scalenostoma sublata* (Broderip, 1832)
According to Dr. Anders Warén of Sweden, this species has 18 synonyms. Up until now this had been found in all tropical seas with the exception of the Eastern Pacific.
3. *Cypraea talpa* Linnaeus, 1758
Altogether I found 5 living specimens of this and Captain Richard Callaway (of Balboa, Panama) who was with me, found 2 more.
4. *Cypraea* n. sp.
This species is in press in the *Venus*. It is being described by Dr. Burgess who tells me that this is found from Australia through the central Pacific. He has examined this shell and confirmed its identity. Captain Callaway also collected one specimen.
5. *Charonia tritonis* (Linnaeus, 1758)
This unique specimen was found living at 120 ft.

6. *Favartia garrettii* (Pease, 1869)

Up until now, this has been known only from the Hawaiian Islands. I have had an unidentified *Favartia* in my collection for some time from La Cruz de la Huantecoxtle, which is approximately 30 miles north of Puerto Vallarta, Mexico, which also proves to be this species.

7. *Persicula pulchella* (Kiener, 1834)

This was a single dead specimen.

The following four species have been found on other offshore islands, but not previously at Cocos Island.

1. *Bursa granularis* (Röding, 1798)
This has been reported from Clipperton Island. The largest specimen I collected measures 72 mm.
2. *Cypraea caputserpentis* Linnaeus, 1758
This has also been reported from Clipperton Island.
3. *Pseudocypraea adamsonii* (Sowerby, 1832)
This has been known from the Galapagos, and I reported collecting one specimen at La Plata Island, Ecuador last year.
4. *Coralliophila neritoides* (Lamarck, 1816)
This is known from the Galapagos and Clipperton Island. It is abundant on stony coral heads.

PALEOECOLOGY AND MOLLUSCAN FAUNA OF THE ESMERALDAS FORMATION OF ECUADOR

Gary Rosenberg
Museum of Comparative Zoology
Harvard University, Cambridge, MA

Analysis of a large collection of molluscs from the Esmeraldas Formation reveals that the fauna inhabited a muddy substrate on the continental shelf at 50-100 meters depth. Almost 80% of the molluscan species of this early Late Pliocene formation are extinct, illustrating limitations of the Lyellian system of dating.

TERTIARY MOLLUSCAN DISTRIBUTIONS FROM BAJA CALIFORNIA SUR, MEXICO

Judith Terry Smith
U.S. Geological Survey
Menlo Park, CA

Molluscan data provide valuable information on the geologic history of the Gulf of California and the paleogeographic reconstruction of Baja California. Marine waters first entered the southern part of the gulf about 5 million years ago, and the fauna has been the same since the middle Pliocene. The Baja California peninsula is composed of a mosaic of geologic terranes, each with a distinctive stratigraphic and tectonic history. Some terranes (e.g., the Viscaïno peninsula) may have traveled far; others are autochthonous within the Pacific-Panamic faunal province. Fossiliferous strata that overlie adjacent terranes constrain the time they came together. First occurrences of exotic taxa, provincial extinctions, and phylogenetic sequences of index species are used to date and correlate formations in the Viscaïno peninsula, the Magdalena Plain, the Purisima area, the Cabo Trough, and the Gulf of California.

Newly collected fossils indicate that major revisions are necessary in the age assignments of earlier literature. Miocene mollusks typical of a mangrove environment were collected in the Cabo Trough from the basal part of the Trinidad Formation, which was previously regarded as a deep-water deposit. Miocene taxa from the type section of the "Pliocene" Salada Formation are correlative with the middle Miocene Gatun Formation of Panama. A Miocene strandline is preserved near Todos Santos, where nonmarine vertebrate fossils overlie beach deposits containing *Vasum* sp. cf. *V. pufferi*, *Turritella abrupta*, and *Cancellaria* (*Pyrucia*) sp. cf. *C. (P.) diadela*. Caribophile *Melongena melongena consors*, *Cymia cheloma*, and *Turritella* 5 spp. document that Tertiary Caribbean Province index fossils of middle Miocene age occur in Baja California. Caribbean species also occur near La Purisima in the Miocene Isidro Formation with *Rapana imperialis*, a cognate of the Holocene *R. bezoar* from the western Pacific and a descendant of *R. vaquerosensis* from the Oligocene of California. systematic treatment is complicated for these taxa, many of which have different western Atlantic, western Mexican, Californian, and South American names.

An important question is: Did Tertiary Caribbean assemblages range northward to Baja California, or have some been transported as parts of tectonic terranes? Oceanic currents, possibly related to unusually strong El Niño effects, have been considered a likely vehicle for distribution, but many taxa (including *Melongena* and *Turritella*) undergo direct development or have a very short planktotrophic larval stage. Dispersal mechanisms must be determined for the whole Tertiary Caribbean assemblage and geographic range considered within a tectonostratigraphic context.

GALÁPAGOS ISLANDS MARINE INVERTEBRATE EVOLUTION: A NEW PATTERN EMERGES

M. J. James and P. F. Fields
Dept. of Paleontology
University of California, Berkeley, CA

Recent work on the fossil and living marine invertebrates of the Galápagos Islands reveals that most fossils examined to date are the same species as their living analogues. This suggests that the evolutionary rates of these taxa have been much slower than for the highly celebrated terrestrial vertebrate fauna.

MINISYMPOSIUM: AVIAN MOLLUSCIVORES

David R. Lindberg, presiding
Dept. of Paleontology
University of California, Berkeley, CA

INTRODUCTORY REMARKS

David R. Lindberg

DESIGNER LIMPETS AND THEIR AVIAN CONSUMERS

Fred Sorenson
Moss Landing Marine Laboratories, Moss Landing, CA

The limpet *Collisella pelta* has different shapes and forms on different substrates. Movement between substrates results in color patterns that make them conspicuous to avian predators. Transitional forms show up in higher proportions in Black Oystercatcher (*Haematopus bachmani*) middens than in the surrounding environment.

INTERTIDAL COMMUNITY STRUCTURE IN CENTRAL AND SOUTHERN CALIFORNIA: THE INTERACTION BETWEEN HUMAN DISTURBANCE, BIRD PREDATION, AND LIMPET TERRITORIALITY

David R. Lindberg, James A. Estes,
and Kenneth I. Warheit
Center For Coastal Marine Studies
University of California, Santa Cruz, CA

The presence or absence of the territorial limpet *Lottia gigantea* determines species diversity and abundances in the high and mid intertidal zones. The abundance of *L. gigantea*, in turn, is determined by the abundance of oystercatchers and humans. Humans also determine the abundance of oystercatchers.

CONTRIBUTED PAPERS: FRESHWATER MOLLUSKS

Louise Russert-Kraemer, presiding
Dept. of Zoology, University of Arkansas
Fayetteville, AR

NAIADES OF THE CURRENT RIVER BASIN, MISSOURI

Alan C. Buchanan
Missouri Dept. of Conservation, Columbia, MO

Over 2,700 specimens of 32 species of naiades were found at 33 sites in the Current River Basin. Cold spring inflows reduced abundance and diversity.

A SURVEY OF THE FRESHWATER MUSSELS OF THE KANAWHA RIVER, WEST VIRGINIA

Ralph W. Taylor
Marshall University, Huntington, WV

Twenty-seven species of freshwater mussels plus the Asian clam were collected; most were concentrated immediately below Kanawha Falls. The lower 75 miles of the river is devoid of mussel life.

THE DISTRIBUTION OF UNIONIDAE IN THE CALCASIEU RIVER IN SOUTHWESTERN LOUISIANA (BIVALVIA: UNIONOIDA)

David H. Stansbery and Michael A. Hoggarth
Museum of Zoology, Ohio State University
Columbus, OH

A series of eleven study sites on the main stem of the Calcasieu River revealed a fauna of twenty-one species of unionids and two species of sphaeriids distributed over the nine uppermost sites. The lower two sites yielded six species of marine or estuarine bivalves and no unionids.

UNIONIDS OF THE LOWER RIO GRANDE SYSTEM, UNITED STATES, AND MEXICO

R. W. Neck and A. L. Metcalf
Texas Parks and Wildlife Dept, Austin, TX
Dept. of Biological Sciences
University of Texas at El Paso, El Paso, TX

Biogeographical reasons for the restricted number of native unionids (ten) in the Lower Rio Grande system are discussed in light of past and present geological environments.

BIOGEOGRAPHY OF FRESHWATER MUSSELS

Mark Gordon
Dept. of Zoology, University of Arkansas
Fayetteville, AR

Freshwater mussels dispersed widely with the formation of Pangea. Unionacea dispersed easterly and westerly from Asia to colonize all continents. Mutelacea radiated in South America and Africa with limited dispersal into North America and India. Vicariance, related to plate tectonics and climate, has resulted in present distributional and phylogenetic relationships.

ORIENTATION OF *LAMPSILIS RADIATA* *LUTEOLA* (LAM.) (BILVALVIA: UNIONIDAE) IN THE EAST FORK OF THE LITTLE SANDY RIVER, BOYD COUNTY, KENTUCKY

Karen J. Horn
Dept. of Biological Science
Marshall University, Huntington, WV

Mussels position themselves with the posterior end upstream (Baker, 1928). Demes of *Lampsilis r. luteola* are examined with respect to this orientation and influencing factors are considered.

AN ANALYSIS OF NAIAD CHROMOSOMAL MORPHOLOGY (BIVALVIA: UNIONACEA)

John J. Jenkinson
Ohio State University & Tennessee Valley Authority
Clinton, TN

Chromosome spreads from a number of North American freshwater mussels have been measured and analyzed. These data will be reviewed with regard to taxonomy.

INDUCTION OF COLOR MORPHS IN *CORBICULA*

Robert S. Prezant and Kashane Chalermwat
Dept. of Biology
University of Southern Mississippi
Hattiesburg, MS

Distinct differences in internal shell color on the Asiatic clam *Corbicula* reflect the condition of the bivalve at the time of collection or the trophic and thermal regime in which the bivalve is grown.

DOES AMBIENT OXYGEN TENSION LIMIT THE DISTRIBUTION OF FRESHWATER SNAILS?

Robert W. Hanley

Dept. of Biology, University of Alabama
University, AL

This study attempts to clarify the relationships between ambient oxygen tension and oxygen consumption in freshwater snails. Eleven species maintain constant metabolic rate over wide ranges of ambient oxygen tensions.

ECOLOGY AND ZOOGEOGRAPHY OF SOME MAINLAND CHINESE *TRICULA* (GASTROPODA: PROSOBRANCHIA: POMATIOPSIDAE) TRANSMITTING SCHISTOSOMES

K. E. Hoagland, Y. Kuo, G. M. Davis,
P. Chen, H. Yang, and D. Chen

Academy of Natural Sciences of Philadelphia;
Lehigh University; Chinese Academy of Medical
Sciences; Yunnan Provincial Anti-Epidemic Station;
Dali Anti-Schistosomiasis Institute, Yunnan, China

The genus *Tricula* is highly speciose in Southern China. At least 3 species transmit schistosome parasites. Ecological and distributional patterns are reported for *Tricula* spp. and compared with those of other snail hosts of schistosomes.

THE LIMPET GENUS *BRONDELIA* AMONG THE FRESHWATER GASTROPODS

J. B. Burch

National Museum of Natural History, Washington, D C
and Museum of Zoology, University of Michigan
Ann Arbor, MI

A careful search at the type locality for *Brondelia* Bourguignat, 1862 failed to produce any specimens. Subsequent inspection of type specimens revealed that both nominal species are actually the marine pulmonate *Williamia gussoni* Costa.

ONTOGENY OF THE LARVAL FOOT OF *CORBICULA FLUMINEA* (BIVALVIA: CORBICULIDAE)

Louise Russert-Kraemer

Dept. of Zoology, University of Arkansas
Fayetteville, AR

Correlated studies of behavior, microscopic serial sections, and SEM reveal that: (1) the foot develops from the apex of the trochophore larva; (2) early differentiation of statocysts accompanies onset of vigorous activity of the juvenile foot; and (3) the juvenile foot is comprised of "segmented" rings of tissue which achieve much more rapid, versatile locomotion than is found in the adult clam.

CONTRIBUTED PAPERS: CEPHALOPODA

Roger T. Hanson, presiding

Marine Biomedical Institute, University of Texas
Galveston, TX

CHARACTERS AND CLASSIFICATION — A PRELIMINARY REVIEW OF THE GENERA IN THE SUBFAMILY OCTOPODINAE

Ronald B. Toll

Division of Mollusks
National Museum of Natural History, Washington, DC

Preliminary results of a study of morphologic variation in the subfamily Octopodinae suggest that a systematic revision of the group will result in a substantial reduction in the number of valid genera.

SYSTEMATICS OF *GONATUS TINRO* FROM THE SOUTHEASTERN BERING SEA

Christopher G. Bublitz

Fishery Industrial Technology Center
University of Alaska, Fairbanks, AK

The literature lacks information on the specific classification of juvenile *Gonatus tinro*. Examination of 181 specimens ranging in size from 6.7 to 68.3 mm shows that *G. tinro* can be separated from other members of the genus on the basis of the arm and tenacle armature development. Conflicting descriptions of juvenile *Berrytheuthis magister* and *G. tinro* found in the literature are also resolved by this study.

CATALOG OF WORLDWIDE CEPHALOPOD RESOURCES: A PREVIEW

Clyde F. E. Roper and Michael J. Sweeney

Dept. of Invertebrate Zoology

National Museum of Natural History, Washington, DC

An annotated and illustrated catalog of the cephalopod species of interest to fisheries around the world has been prepared for publication by the Food and Agriculture Organization of the United Nations (FAO).

SQUIDS CAUGHT IN SURFACE GILLNETS IN THE SUBARCTIC PACIFIC, 1977-1981

Tsunemi Kubodera

School of Oceanography

Oregon State University, Corvallis, OR

Distribution, relative abundance, size composition, and maturity of three common squids, *Gonatopsis borealis*, *Onychoteuthis borealijaponica*, and *Ommastrephes bartrami*, taken in surface gillnets in the northern North Pacific during May to August, 1977-1981 are discussed.

DYNAMICS OF SHALLOW-WATER POPULATIONS OF *OCTOPUS DOFLEINI*

Richard F. Ambrose

Dept. of Biological Sciences

Simon Fraser University, Burnaby, BC

Population fluctuations, size distributions, immigration, recruitment, and the sex ratio of populations of *Octopus dofleini* were studied. Movements of tagged octopuses were also recorded.

FJORD/ISLAND ECOLOGY OF A POPULATION OF SEPIOLID SQUID

William C. Summers

Huxley College, Western Washington University
Bellingham, WA

Circulation in the deep basin of a Swedish fjord is related to the population parameters of the nekto-benthic squid, *Sepietta oweniana*.

COMPENSATORY BUOYANCY CHANGE IN *NAUTILUS MACROMPHALUS*

Peter Ward

Dept. of Geology, University of California
Davis, CA

Apertural shell breakage stimulates chamber refilling, hence compensatory buoyancy change in *Nautilus macromphalus*. Observations on 20 aquarium maintained specimens showed the greatest in-water weight change (0.15 g/hr) to occur in the first ten hr after shell breakage. Subsequent buoyancy change was much lower (0.05 g/hr).

THE ROLE OF MANTLE ELASTICITY IN SQUID SWIMMING

M. Edwin Demont and J. M. Gosline

Zoology Dept., University of British Columbia
Vancouver, BC

An elaborate network of collagen fibers in the mantle stores energy from the contraction of the circular muscles. This stored energy is available to power mantle re-expansion and presumably improves swimming performance.

STATOLITH DEVELOPMENT AND AGE DETERMINATION IN THE OMMASTREPHID SQUID *ILLEX ILLECEBROSUS* (LESUEUR, 1821)

C. C. Morris, and F. A. Aldrich

Dept. of Biology, University of Newfoundland
St. John's, NF

The first developmental series of a cephalopod statolith is discussed. A tracing method of recording growth increments in the statolith is detailed. The use of statolith size and increment numbers to determine age is discussed also.

ULTRASTRUCTURAL OBSERVATIONS OF THE CEPHALOPOD LENS

Becky A. Houck

University of Portland, Portland, OR

Ultrastructural observations of the lens of the embryonic octopus eye reveal a regular array of hexagonal lens fibers of dimensions 0.8 microns by 0.4 microns. This hexagonal lens structure is similar to that found in the human eye.

STRUCTURE AND LIGHT REFLECTING PROPERTIES OF IRIDOPHORES IN THE SQUID *LOLLIGUNCULA BREVIS*

R. T. Hanlon, K. M. Cooper and R. A. Cloney
Marine Biomedical Institute, University of Texas,
Galveston, TX and Dept. of Zoology,
University of Washington, Seattle, WA

The structure of the iridophores in the mantle dermis of the common bay squid *Lolliguncula brevis* was examined with light and electron microscopy. Light reflecting properties of these iridescent cells were described.

CUTTLEBONE MORPHOLOGY AND BATHYMETRY IN *SEPIA*

Peter Ward

Dept. of Geology, University of California, Davis, CA

Recent experiments show that the cuttlebone of *S. officinalis* and *S. orbignyana* implode due to excess pressure at quite different depths. An analysis of cuttlebone morphology in approximately half of the known cuttlebone species indicates that cuttlebone morphological differences can be explained mainly as adaptations for different preferred habitat depths.

CARBOHYDRATE CONSERVATION IN A CEPHALOPOD, *OCTOPUS DOFLEINI*

A. W. Martin and I. Deyrup-Olsen
Dept. of Zoology, University of Washington
Seattle, WA

Inulin, dextrans, and 2-deoxyglucose are accumulated by various organs (branchial heart, reno-pericardial canal, renal appendages, gills) where carbohydrate loss from the body would be possible. Lectin mechanisms are implicated in the uptake of the polysaccharides, and these, as well as glucose transport, may result in 2-deoxyglucose accumulation.

ESCAPE BEHAVIOR OF *ROSSIA PACIFICA*

Ronald L. Shimek
Bellevue, WA

Rossia pacifica has stereotyped escape response to slow swimming predators. The squid swims parallel to the bottom, and changes color and discharges ink in a predictable manner. The response is somewhat labile, depending upon a series of factors including squid size, current velocity, predator velocity, and water transparency.

VISUAL DISCRIMINATION TRAINING EXPERIMENTS WITH LABORATORY REARED *OCTOPUS MAYA* AND *OCTOPUS BIMACULOIDES*

R. T. Hanlon, J. F. Forsythe, and J. B. Messenger
Marine Biomedical Institute, University of Texas
Galveston, TX

Young and old octopuses were trained to discriminate visually between plastic rectangles differing in (1) brightness, (2) shape, or (3) orientation.

OBSERVATION ON THE REPRODUCTIVE BIOLOGY OF *OCTOPUS BURRYI* VOSS, 1950

John W. Forsythe

Marine Biomedical Institute, University of Texas
Galveston, TX

A trawl-caught, mature female laid a large clutch of eggs in the laboratory. Fecundity, brooding, behavior, development time, and hatching behavior are described.

NOTES ON THE LABORATORY CULTURE OF *OCTOPUS BIMACULOIDES*, THE CALIFORNIA MUD FLAT OCTOPUS

J. W. Forsythe, R. H. DeRusha, and R. T. Hanlon
Marine Biomedical Institute, University of Texas
Galveston, TX

Laboratory spawned *Octopus bimaculoides* were reared from hatching to sexual maturity in closed-recirculating-seawater systems. Data were obtained on feeding, growth, survival, and intraspecific behavior.

LABORATORY CULTURE OF THE SQUID *LOLIGO OPALESCENS* THROUGH THE ENTIRE LIFE CYCLE

R. F. Hixon, W. T. Yang, P. E. Turk, R. T. Hanlon, and M. Parsons
Marine Biomedical Institute, University of Texas
Galveston, TX

Squids were cultured from eggs to adults in eight months using closed-system aquariums. Data on survival, feeding, growth, sexual maturation, and behavior were obtained.

**DAILY GROWTH RINGS IN THE
STATOLITHS OF YOUNG LABORATORY-
CULTURED SQUIDS (*LOLIGO OPALESCENS*)**

R. F. Hixon and M. R. Villoch
Marine Biomedical Institute, University of Texas
Galveston, TX

Growth rings were counted in decalcified statoliths from laboratory cultured squids of a known age. Comparisons showed the rings were formed daily.

**FATAL PENETRATING SKIN ULCERS IN
LABORATORY-REARED *OCTOPUS JOUBINI*
AND *O. BRIAREUS***

R. T. Hanlon, D. S. Folse, and M. T. Kelly
Marine Biomedical Institute, University of Texas
Galveston, TX

One-month-old octopuses reared in groups developed fatal bacterial ulcers that could be treated successfully with furanace. Individually reared animals in the same system remained disease-free.

**CONTRIBUTED PAPERS:
PACIFIC NORTHWEST AND
ALASKA MARINE MOLLUSCS**

Ronald L. Shimek, presiding
Bellvue, WA

**LARVAL DEVELOPMENT OF THE
"GUTLESS" PROTOBRANCH BIVALVE
SOLEMYA REIDI BERNARD 1980
(BIVALVIA: PROTOBRANCHIA)**

Richard Gustafson
Dept. of Biology, University of Victoria
Victoria, BC

Development and morphogenesis of *Solemya reidi* was followed throughout the six-day lecithotrophic larval stage at 10°C using light and scanning electron microscopy. *S. reidi* is not gutless throughout its life.

**THE BENTHIC ECOLOGY OF A GUTLESS
PROTOBRANCH BIVALVE, *SOLEMYA REIDI***

Penelope A. Gee
Dept. of Biology, University of Victoria
Victoria, BC

Solemya reidi, a recently described benthic proto-branch bivalve from the northeastern Pacific Ocean, possesses neither a gut nor internal enzymatic apparatus. High densities of this animal appear limited to sediments below wood-fibre beds. An effort has been made to relate the animal's density and distribution to a number of environmental parameters. Current research incorporates recent information on the animal's possible modes of nutrition.

**A NEW COMMENSAL BIVALVE
FROM VANCOUVER ISLAND**

Diarmaid O'Foighil
Dept. of Biology, University of Victoria
Victoria, BC

The morphology, ecology, and reproduction of a new species of *Scintillona* were studied and compared with that of other commensal Galeomatacean bivalves.

**BROODING AND ADULT SIZE IN
TRANSENELLA TANTILLA
(BIVALVIA: VENERIDAE)**

Alan R. Kabat
Spokane, WA

The allometry of brooding in *T. tantilla*, a small bivalve is analyzed. The number of brooded embryos and the brood weight of both increase with adult width squared. The role of parental care and the possible mechanism of larval dispersal are considered.

**BIVALVE ASSEMBLAGES IN
NORTON SOUND, ALASKA: POPULATION
STRUCTURE AND EFFECTS OF PREDATION**

Allan K. Fukuyama
Moss Landing Marine Laboratories, Moss Landing, CA

Bivalve population structure was studied during the summers of 1982-1983. Bivalves 1-10mm in size are affected by seastar predation while bivalves greater than 40mm are seasonally affected by walrus predation.

ASPECTS OF THE LARVAL BIOLOGY OF TWO *OENOPOTA* (GASTROPODA: TURRIDAE) SPECIES

Ronald L. Shimek

Bellevue, WA

Oenopota levidensis and *O. fidicula* have demersal, planktotrophic veligers. Settlement occurs four to five weeks after hatching, and hatching occurs three to four weeks after egg capsule deposition. Settling may be triggered by settlement of juveniles of prey polychaetes.

LARVAL DEVELOPMENT AND METAMORPHOSIS OF *MELIBE LEONINA* (NUDIBRANCHIA), WITH OBSERVATIONS ON NEUROGENESIS

Louise Bickell

Dept. of Biology, University of Victoria
Victoria, BC

Morphogenesis during the larval and metamorphic stages of *Melibe leonina* is described, with emphasis on the development of the cerata and the establishment of central innervation.

NORTH ATLANTIC-PACIFIC NUDIBRANCH COGNATES

Sandra V. Millen

University of British Columbia, Vancouver, Canada

Several cognate species of nudibranchs living in the Atlantic and Pacific oceans were examined using scanning electron microscopy and conventional dissections to determine if they exhibited morphological differences. The cognates *Onchidoris muricata* (Müller, 1776) of the Atlantic and *O. varians* (Bergh, 1878) of the Pacific appear to be identical when similar sized specimens are compared, but in the Norwegian Sea they are larger with the notal tubercles disproportionately larger. These larger specimens are usually confused with *Adalaria lovéni* (Alder & Hancock, 1862). During this study it was discovered that the description of *Onchidoris hystricina* (Bergh, 1878) fell within the description of *O. muricata* and is therefore a junior synonym. The animal which is commonly considered to be *O. hystricina* upon examination was found to be a *Diaphorodoris*. Another Pacific species, which has been referred to as *Onchidoris* sp., was found to have the multiple lateral teeth of an *Adalaria*. A reassessment of Bergh's 1978 criteria for distinguishing the genera *Onchidoris* and *Adalaria* found that all the criteria except the number of lateral teeth were invalid. This is a tenuous distinction as some *Adalaria* have as few as five laterals per side. If intermediate forms are found in the future it will be necessary to synonymise these genera. The second cognates, *Adalaria proxima* (Alder & Hancock, 1854) from the Atlantic and the Pacific *A. pacifica* Bergh, 1880 were

found to vary only slightly from each other. The differences could possibly be due to preservation artifacts. It was concluded that these two species are synonymous.

BIOLOGICAL ADAPTATIONS OF INTERSTITIAL MOLLUSCS

M. Patricia Morse

Marine Science Laboratory
Northeastern University, Nahant, MA

Interstitial molluscs are characteristic of shifting coarse sand environments. Major molluscan taxa represented include solenogasters, acochliideans and species of the nudibranch genus *Pseudovermis*. All of these offer examples of regressive evolution toward vermiformity for living in the pore spaces of the environment.

CONTRIBUTED PAPERS: TERRESTRIAL MOLLUSKS

Barry Roth, presiding

Dept. of Invertebrate Zoology
California Academy of Sciences
San Francisco, CA

PACIFIC ISLANDS REVISITED — BIOGRAPHY OF A RECENTLY EXTINGUISHED LAND SNAIL FAUNA

Alan Solem

Dept. of Zoology
Field Museum of Natural History, Chicago, IL

Analysis of the land snail families Endodontidae and Charopidae on the Pacific Islands show a pattern of minor geographic changes that do not correlate with tectonic events. Most of this radiation has become extinct within the past 50 to 150 years because of man-made habitat alterations or introductions.

PRELIMINARY STUDIES ON THE KARYOTYPES OF BRADYBAENIDAE (GASTROPODA: PULMONATA)

Noorullah Babrakzai and W. B. Miller

Dept. of Biology
Central Missouri State University, Warrensburg, Mo
Dept. of General Biology, University of Arizona
Tucson, AZ

Chromosome study of *Bradybaena similaris*, *B. (Acusta) despecta sieboldiana*, and two species of *Euhadra*, reveals the unique nature of the karyotype of *B. similaris*; in having 26 pairs of telocentric and only two pairs of metacentric chromosomes.

ELECTROPHORETIC VARIATION WITHIN THE TWO POLYGYRID LAND SNAIL GENERA *MESODON* AND *TRIODOPSIS*

Kenneth C. Emberton
Committee on Evolutionary Biology
University of Chicago, Chicago, IL

Some 70 nominal species were examined at 16 presumed genetic loci as part of an attempt to understand the evolutionary patterns of two genera that share multiple conchological convergences, often in sympatry.

SYSTEMATIC RELATIONSHIPS OF THE *ORTHALICUS* OF FLORIDA

Jane E. Deisler
Florida State Museum, Gainesville, FL

The gross anatomy of *Orthalicus floridensis* Pilsbry and *O. reses* (Say) is summarized. The results of covariance analysis of quantitative shell traits are compared to the dendrogram produced by cluster analysis of these traits for these species and for *O. undatus jamaicensis* Pilsbry. The genital anatomy and shell pigmentation define two species of *Orthalicus* in Florida. However, the quantitative shell traits are too variable to define the taxa.

HISTOLOGY AND ULTRASTRUCTURE OF THE VAS DEFERENS IN SELECTED TERRESTRIAL PULMONATES

Richard L. Reeder
Faculty of Natural Sciences, University of Tulsa
Tulsa, OK

Comparative histological and ultrastructural studies of the vas deferens in several species of Helminthoglyptidae and Polygyridae indicate that the duct is relatively uniform in some groups while having a modified region near the spermoviduct junction in others.

RADIOCENTRUM AVALONENSE IS ALIVE AND WELL(?) ON CATALINA ISLAND

F. G. Hochberg, Barry Roth
Santa Barbara Museum of Natural History
Santa Barbara, CA

and
Walter B. Miller
Department of General Biology, University of Arizona
Tucson, AZ

In 1902 Henry Hemphill discovered an unusual oreohelicid snail on Santa Catalina Island, California. The specific name, *avalonense*, suggests that the snail was originally collected in the vicinity of the town of Avalon. However, in spite of repeated attempts the snail could not be found again and was reported to be extinct.

In 1982 a small population of live snails was located about 2½ miles south and west of Avalon. Extensive surveys have failed to turn up the snail in other areas on the island, hence, we conclude that it is restricted to the southeastern tip of the island. Here it occurs only on steep, sparsely vegetated, south-facing slopes dominated by Black Sage (*Salvia mellifera*) and Prickly Pear Cactus (*Opuntia littoralis*). The small, sluggish snail lives deep in talus piles and emerges only in wet weather to feed on *Salvia*.

Conchologically the species is typical of the family Oreohelicidae. The shell is lens-shaped and distinctly carinate. At maximum size the shell diameter is 14 mm and there are 5½ whorls. The radially ribbed embryonic shell is diagnostic of the genus *Radiocentrum*. However, until live specimens were discovered generic placement could not be verified. Specimens from Catalina Island were found to have a reproductive system identical to the oviparous genus *Radiocentrum*. In addition to the large albumen gland, swollen lower third of the spermathecal duct and much enlarged, hatchet-shaped upper penis characteristic of the genus, *R. avalonense* is further defined by a distinctly swollen lower penis with 3 conspicuous longitudinal ridges.

The genus *Radiocentrum* was once widely distributed throughout western North America. Climatic changes have dramatically restricted the range of the genus. The distribution of Quaternary taxa has been further reduced and fragmented by the imprint of the Sonoran and Chihuahuan deserts. The majority of the species in the genus are relicts which persist in small isolated localities. Typical of such relicts only a few scattered, low density colonies of *R. avalonense* have been found on Catalina Island. Several related species in Texas and Mexico are known only from empty shells indicating the continued extinction of outlying populations. As an outlier, *R. avalonense* lives a precarious existence under less than optimal conditions. Considered potentially vulnerable to extinction, protective status is warranted for this rare, insular endemic.

ARE EUGLANDINA AND GONAXIS EFFECTIVE AGENTS FOR BIOLOGICAL CONTROL OF THE GIANT AFRICAN SNAIL IN HAWAII?

Carl C. Christensen
Bernice P. Bishop Museum, Honolulu, HI

Despite frequent assertions of successful biocontrol, published studies do not demonstrate these predators to be effective in the control of *Achatina fulica*.

CONTRIBUTED PAPERS: MARINE MOLLUSKS

M. Patricia Morse, presiding
Marine Science Laboratory, Northeastern University
Nahant, MA

SHELL REDUCTION AND LOSS IN FISSURELLIDS: A REVIEW OF GENERA AND SPECIES IN THE FISSURELLIDEA GROUP

James H. McLean

Los Angeles County Museum of Natural History
Los Angeles, CA

Six species in three related genera, the *Fissurellidea* group, have leathery extensions of the mantle covering the head and foot, a broad rachidian tooth, and the shell vestigial or lacking.

Fissurellidea Orbigny, 1841, has a radially striate shell and comprises the type species *F. megatrema* Orbigny, 1841, in southern Argentina, *F. patagonica* (Strebel, 1907) in southern Chile and southern Argentina, and *F. bimaculata* Dall, 1871, in the northeastern Pacific. *Megatebennus* Pilsbry, 1890, proposed originally for the latter, is synonymized with *Fissurellidea*.

Pupillea Sowerby, 1835, differs from *Fissurellidea* in having a higher shell profile and in having two shell layers offset at the margin. It comprises the type species *P. aperta* (Sowerby, 1825) in South Africa, and *P. annulus* (Odhner, 1932) in southern Chile. The latter has a ringlike shell, an extreme vestige.

Buchanania onchidiodes Lesson, 1830, from southern Chile, here subsequently recognized for the first time, lacks a shell as an adult, but is otherwise like other members of the *Fissurellidea* group; it has groove in which there is probably a shell in early stages. The latter genus completes the trend toward shell reduction in the tribe Fissurellidini.

INTERTIDAL LIMPETS: PARADOXICAL PARADIGMS

David R. Lindberg

Museum of Paleontology, University of California
Berkeley, CA

Biological studies of patellacean limpets have greater resolution when shell structure groups are recognized. The taxonomy of the patellaceans is reexamined.

THE EVOLUTION OF BROODING IN ACMAEID LIMPETS

David R. Lindberg

Museum of Paleontology, University of California
Berkeley, CA

Brooding has evolved in only one acmaeid shell structure group, and the methods of fertilization, embryo nourishment, and brooding differ among the brooding species.

REVISION OF HIGHER TAXA IN GENUS CERITHIDEA BASED ON COMPARATIVE MORPHOLOGY AND BIOLOGICAL DATA

Richard Houbbrick

Dept. of Intervertebrate Zoology, National Museum of
Natural History, Smithsonian Institution
Washington, DC

The comparative morphology of *Cerithidea* species is examined to supply characters for a cladistic analysis of the subgenera. Reproductive, ecological, and paleontological data are used to test the cladogram and to arrive at a classification.

BIOGEOGRAPHICAL AFFINITIES OF THE OPISTHOBRANCH GASTROPOD FAUNA OF SOUTHERN AFRICA

Terrence M Gosliner

Division of Mollusks
California Academy of Sciences, San Francisco, CA

The convergence of the Indian and Atlantic Oceans represents a critical area for studying the distribution of marine organisms. Two distinct opisthobranch faunas are found in the region.

BURROWING ACTIVITIES OF PERIPLOMA (BILVALVIA: ANOMALODESMATA)

Joseph Rosewater

Division of Mollusks, Dept. of Invertebrate Zoology
National Museum of Natural History, Washington, DC

Periploma margaritaceum (Lamarck, 1801) used its siphons as a bellows to cleanse the mantle cavity of substrate entering during burrowing. This appears to replace muscular adduction done by clams having stronger shells.

**A REVIEW OF THE BIVALVE GENERA
AXINULUS VERRILL & BUSH, 1898,
LEPTAXINUS VERRILL & BUSH, 1898
AND *ADONTORHINA* BERRY, 1947
WITH NOTES ON A NEW SPECIES OF
THYASIRIDAE**

Paul H. Scott

Santa Barbara Museum of Natural History
Santa Barbara, CA

A new species of Thyasiridae has been found in deep water in the Northeast Pacific. Generic placement of the species proved difficult as it exhibited characters of the genera *Axinulus*, *Leptaxinus* and *Adontorhina*.

Type material of the three genera was examined to determine the correct generic placement for the new species. Inspection of the hinge plate proved to be the most useful character in differentiating the genera.

Distinctive characters of the genera are defined below.

Axinulus Verrill & Bush, 1898 (8 North American species, 7 species examined). Type species *Axinulus brevis* V & B, 1898 hinge plate thin, smooth and edentulous

— minute hinge tubercles present in some species.

Leptaxinus Verrill & Bush, 1898 (1 North American species). Type species *Leptaxinus minutus* V & B, 1898 hinge plate narrow but well developed

— right valve with small tubercle beneath umbo which fits into corresponding notch in the left valve hinge
— right valve with long lateral grooves along anterior and posterior of the hinge plate into which the shell margin of the left valve is seated.

Adontorhina Berry, 1947 (1 North American species). Type species *Adontorhina cyclia* Berry, 1947 hinge plate broad with a unique granular appearance.

— hinge granules distinct anteriorly, weakly expressed posteriorly.

The new northeastern Pacific species has a broad granular hinge plate placing it in the genus *Adontorhina* Berry, 1947.

**MOLLUSCAN PREDATION BY THE
HORSESHOE CRAB *LIMULUS POLYPHEMUS***

George D. Buckley

Pleasant Bay Field Station, South Orleans, MA

This presentation will summarize the results of a study to determine the role of molluscs in the diet of the horseshoe crab, *Limulus*. It shows how the crab may benefit clammers and shell collectors.

GROWTH IN *MERCENARIA MERCENARIS* (L.)

A. G. Eversole, P. J. Eldridge and L. W. Grimes
Clemson University, Clemson, SC

Shell dimensions and growth of individual clams were monitored over 4.5 years. These data will be discussed in relation to the mechanisms of growth adjustment in molluscs.

PAPERS SUBMITTED FOR PUBLICATION

(Not presented at annual meeting)

A PRELIMINARY CHECKLIST OF MARINE MOLLUSKS FROM MANABI PROVINCE, ECUADOR

Donald R. Shasky

834 W. Highland Ave., Redlands, CA 92373

Manabi Province, Ecuador, is the site of both Salango and La Plata islands. It is also the site of the mainland village of Salango. These sites are rich in archeological artifacts from perhaps as early as 3000 B.C. In Sept. 1978, June 1979, and June 1980, I was the SCUBA diver-malacologist for the Program for New World Anthropology. My assignment was to attempt to find living specimens of *Spondylus princeps*, which had been extensively used in commerce by the ancient coastal Indians of this area. A secondary assignment was to make a malacological survey of these areas. The checklist which follows also encompasses additional mainland sites within the Province.

I have many species that remain unidentified. These are in groups that are difficult to work with such as minute bivalves, *Cerithiopsis*, additional eulimids, *Atlanta*, and additional pyramidellids. I make no apology for publishing this paper before all are identified. This may take several years and additional workers qualified to take on the task.

An * following the species indicates an extension of the known range. Also following the species is a number or numbers indicating where the specimens were taken. The following is a key to the numbers:

1. Isla La Plata
2. Isla Salango
3. Punta Piedras Verdes (near the village of Salango)
4. Punta Mala (between the villages of Salango and Puerto Lopez)
5. Punta Mirador (the south point of the village of Puerto Lopez)
6. Puerto Lopez (dredging site in bay)
7. Puerto Lopez (beach)
8. Puerto Matal (near the village of Jama)

On Isla La Plata I dove to 41 m, Isla Salango to 27 m, and at Punta Mala at 20 m. The richest areas at Isla La Plata, however, were from 11-27 m and at Isla Salango at 11 m.

A small amount of dredging was done at Isla La Plata and Puerto Lopez Bay. The selected dredging sites were not abundantly productive, but several interesting species were found.

A few undescribed species were taken and these will be dealt with in a subsequent paper.

Family Solemyidae

Solemya johnsoni Dall, 1891 * 1

Family Nuculidae

Nucula exigua Sowerby, 1833 6

Family Nuculanidae

Nuculana bicostata (Sowerby, 1871) 6

N. eburnea (Sowerby, 1833) 6

N. elenensis (Sowerby, 1833) 1,2

Adrana crenifera (Sowerby, 1833) 6

Family Arcidae

Arca pacifica (Sowerby, 1833) 1,4

Barbatia rostrae Berry, 1954 4

B. reeveana (Orbigny, 1846) 2

B. illota (Sowerby, 1833) 2,4

Anadara perlabiata (Grant & Gale, 1931) 6

A. emarginata (Sowerby, 1833) 1,4

A. formosa (Sowerby, 1833) 1

Arcopsis solida (Sowerby, 1833) 4

Family Glycymerididae

Glycymeris maculata (Broderip, 1832) 1

G. inaequalis (Sowerby, 1833) 1

G. strigilata (Sowerby, 1833) 1

Family Mytilidae

Brachidontes puntarenensis (Pilsbry & Lowe, 1832) 1,4

Mytella speciosa (Reeve, 1857) 8

Septifer zeteki Hertlein & Strong, 1946 1,2,4

Crenella divaricata (Orbigny, 1846) 2

Gregariella chenui (Récluz, 1842) 1

Lithophaga plumula (Hanley, 1844) 1,4

L. attenuata attenuata (Deshayes, 1836) 2

L. aristata (Dillwyn, 1817) 1

Amygdalum americanum Soot-Ryen, 1955 1

Family Pteriidae

Pteria sterna (Gould, 1851) 1

Pinctada mazatlanica (Hanley, 1856) 1

Family Isognomonidae

Isognomon janus Carpenter, 1857 * 4

Family Ostreidae

Ostrea tubulifera Dall, 1914 * 2

Family Pectinidae

- Pecten perulus* Olsson, 1961 1
- Argopecten circularis* (Sowerby, 1835) 1
- Chlamys lowei* (Hertlein, 1935) 1
- Cyclopecten pernominus* (Hertlein, 1935) 1
- Leptopecten biolleyi* (Hertlein & Strong, 1946) * 1
- L. velero* (Hertlein, 1935) 2,4,5,6
- Lyropecten subnodosus* (Sowerby, 1835) 1,2

Family Spondylidae

- Spondylus calcifer* Carpenter, 1857 1
- S. princeps* Broderip, 1833 1,2

Family Limidae

- Lima tetrica* Gould, 1851 1
- L. pacifica* Orbigny, 1846 4
- L. orbignyi* Lamy, 1930 2

Family Anomiidae

- Anomia peruviana* Orbigny, 1846 1,2

Family Crassatellidae

- Eucrassatella gibbosa* (Sowerby, 1832) 1
- Crassinella ecuadoriana* Olsson, 1961 1,2,4
- C. pacifica* (C. B. Adams, 1852) 1
- C. varians* (Carpenter, 1857) 1

? Family Cardiniidae

- Tellidorella cristulata* Berry, 1963 * 1

Family Carditidae

- Cardita radiata* Sowerby, 1833 2,4
- C. laticostata* Sowerby, 1833 2
- C. megastrophia* (Gray, 1825) 1

Family Condylolcardiidae

- Condylolcardia digueti* Lamy, 1916 * 1
- C. hippopus* (Mörch, 1861) * 1

Family Bernardinidae

- Halodakra subtrigona* (Carpenter, 1857) 1

Family Lucinidae

- Lucina prolongata* Carpenter, 1857 1
- L. centrifuga* (Dall, 1901) * 6
- L. approximata* (Dall, 1901) * 1
- L. mazatlanica* Carpenter, 1857 * 1
- L. leucocymoides* (Lowe, 1935) * 1
- Codakia distinguenda* (Tryon, 1872) 1
- Ctena mexicana* (Dall, 1901) 1

Family Ungulinidae

- Diplodonta inezensis* (Hertlein & Strong, 1847) * 6
- D. subquadrata* (Carpenter, 1856) 1,2
- Phlyctiderma discrepans* (Carpenter, 1857) * 1

Family Galeommataidae

- Cymatiosa electilis* (Berry, 1963) 1
- C. pulchra* (Philippi, 1849) * 1

Family Kelliidae

- Kellia suborbicularis* (Montagu, 1803) 1,4,5

Family Montacutidae

- Orobitella peruviana* Olsson, 1961 1,3
- O. sechura* Olsson, 1961 1
- O. zorrita* Olsson, 1961 1

Family Sportellidae

- Basterotia peninularis* (Jordan, 1936) 1
- B. hertleini* Durham, 1950 1,2

Family Chamidae

- Chama buddiana* C. B. Adams, 1852 4
- C. sordida* Broderip, 1835 * 1
- Pseudochama corrugata* (Broderip, 1835) 1
- P. janus* (Reeve, 1847) 1,2

Family Cardiidae

- Trachycardium pristipleura* (Dall, 1901) 2
- T. senticosum* (Sowerby, 1833) 2
- Papyridea aspera* (Sowerby, 1833) 1
- P. mantaensis* Olsson, 1961 2
- Trigoniocardia granifera* (Broderip & Sowerby, 1829) 6
- T. guanacastensis* (Hertlein & Strong, 1947) 2
- T. ovovalis* (Sowerby, 1833) 6
- Nemocardium pazianum* (Dall, 1916) * 1
- Laevicardium elenense* (Sowerby, 1840) 6

Family Veneridae

- Periglypta multicostata* (Sowerby, 1835) 1
- Ventricularia isocardia* (Verrill, 1870) * 1
- Gouldia californica* Dahl, 1917 2
- Pitar helenae* Olsson, 1961 1,2
- P. hertleini* Olsson, 1961 1,2
- Megapitaria aurantica* (Sowerby, 1831) 1
- M. squalida* (Sowerby, 1835) 2
- Dosinia ponderosa* (Gray, 1838) 1
- Cyclinella jadisi* Olsson, 1961 2
- Chione compta* (Broderip, 1835) 2,6
- C. subimbricata* (Sowerby, 1835) 2
- C. ornativissima* (Broderip, 1835) 6
- C. discrepans* (Sowerby, 1835) * 1
- C. mariae* (Orbigny, 1846) 2, 6
- C. squamosa* (Carpenter, 1857) 1,2
- Petricola denticulata* Sowerby, 1834 3,5,7

Family Mactridae

- Mactra fonsecana* Hertlein & Strong, 1950 1,7
- Mactrellona clisia* (Dall, 1915) 7

Family Tellinidae

- Tellina pacifica* Dall, 1900 * 1
- T. lyra* Hanley, 1844 7,8
- T. rhynchoscutea* (Olsson, 1961) 3,7
- T. cumingii argis* Olsson, 1971 * 1
- Florimetus cognata* (Pilsbry & Vanatta, 1902) 1
- Psammotreta aurora* (Hanley, 1844) 2
- Strigilla chroma* Salisbury, 1934 7
- S. interrupta* Mörch, 1860 7
- S. serrata* (Mörch, 1860) 6
- Temnoconcha cognata* (C. B. Adams, 1852) * 6

Family Donacidae

- Donax gracilis* Hanley, 1845 7
- D. punctatostriatus* Hanley, 1843 7
- D. transversus* Sowerby, 1825 6

Family Psammobiidae

- Gari helenae* Olsson, 1961 1,2
- G. lata* (Deshayes, 1855) 1,2
- Sanguinolaria bertini* Pilsbry & Lowe, 1932 8

Family Solecurtidae

Solecortus broggii Pilsbry & Olsson, 1941 1
Tagelus bourgeoisae Hertlein, 1951 1

Family Semelidae

Semele formosa (Sowerby, 1833) 1
S. junonia (Verrill, 1870) * 2
S. pilsbryi Olsson, 1961 * 1
S. pulchra (Sowerby, 1832) 1,2
S. sparsilineata Dall, 1915 * 1
Abra palmeri Dall, 1915 1,3,6
Cuningia adamsi Olsson, 1961 (*ex*)
Carpenter, 1864 * 1
Semelina subquadrata (Carpenter, 1857) * 1

Family Corbulidae

Corbula marmorata Hinds, 1843 1,2,3
C. nuciformis Sowerby, 1833 1,2,6

Family Hiatellidae

Hiatella solida (Sowerby, 1834) 1,4

Family Pholadidae

Pholadidea melanura (Sowerby, 1834) 7

Family Periplomatidae

Periploma planiusculum 7

Family Cuspidariidae

Cardiomya californica (Dall, 1886) 1
C. eucadoriana (Olsson, 1961) 6

Family Fissurellidae

Diodora inaequalis (Sowerby, 1835) 4
D. pusilla Berry, 1959 * 1,2,4,6
D. saturnalis (Carpenter, 1864) 1
Fissurella microtrema Sowerby, 1835 4,5
F. virescens Sowerby, 1835 1
Leurolepas roseola McLean, 1970 1,2

Family Acmaeidae

Scurria stipulata (Reeve, 1855) * 1,4,6

Family Trochidae

Solariella triplosthephanus Dall, 1910 1
Calliostoma leanum (C. B. Adams, 1852) 2
C. mcleani Shasky & Campbell, 1964 1,2
C. rema Strong, Hanna & Hertlein, 1933 1
Tegula melaleucos (Jonas, 1844) 2
T. panamensis (Philippi, 1849) 2,4

Family Skeneidae

Ganesa (?) *atomus* Pilsbry & Olsson, 1952 1
Parviturbo stearnsii (Dall, 1918) * 1,2

Family Liotiidae

Arene olivacea (Dall, 1918) 2,4
A. fricki (Crosse, 1865) 1,2,4

Family Turbinidae

Turbo mazatlanicus Pilsbry & Lowe, 1932 * 1,2
T. squamiger Reeve, 1843 1

Family Phasianellidae

Tricolia perforata (Philippi, 1848) 4,5
T. phasianella (Philippi, 1849) 4

Family Neritidae

Nerita scabricosta Lamarck, 1822 1
N. funiculata Menke, 1851 1

Family Phenacolepadidae

Phenacolepas osculans (C. B. Adams, 1852) * 1

Family Littorinidae

Littorina aspera Philippi, 1846 1,4
L. modesta Philippi, 1846 1

Family Rissoidae

Alvintia monseerrattensis (Baker, Hanna & Strong, 1930) * 1
Amphithalamus trosti Strong and Hertlein, 1939 * 1

Family Rossoellidae

Rissoella anguliferens (DeFolin, 1870) * 2
R. tumens (Carpenter, 1857) * 1,2

Family Rissoidae

Rissoina axeliana Hertlein & Strong, 1951 * 1,2,4
R. clandestina (C. B. Adams, 1852) * 1,2,4
R. effusa Mörch, 1860 * 1,2,4
R. firmata (C. B. Adams, 1852) * 1,4
R. zeltneri (DeFolin, 1867) * 1,2,4
R. ericana Hertlein & Strong, 1951 * 1
R. signae Bartsch, 1915 * 2

Family Vitrinellidae

Vitrinella martensiana (Hertlein & Strong, 1951) * 4
V. multispiralis Pilsbry & Olsson, 1952 1,4
Cyclostremiscus glyptomphalus Pilsbry & Olsson, 1952 * 6
C. panamensis (C. B. Adams, 1852) * 4
C. parvus (C. B. Adams, 1852) * 2,4
Lydiophnis strongi Pilsbry & Olsson, 1852 4
Parviturboides monile (Carpenter, 1857) * 4
Solariorbis allomphalus Pilsbry & Olsson, 1952 * 4
S. carinatus (Carpenter, 1857) * 4
S. seminudus (C. B. Adams, 1852) * 4
Teinostoma hemphilli Strong & Hertlein, 1939 * 2
Woodringilla glyptulus Pilsbry & Olsson, 1951 2

Family Architectonicidae

Heliacis architae (Costa, 1844) 1
H. bicanaliculatus (Valenciennes, 1832) 4
H. caelatus (Hinds, 1844) * 1,4
H. mazatlanicus Pilsbry & Lowe, 1932 2

Family Turritellidae

Turritella nodulosa King & Broderip, 1832 1,2
T. radula Kiener, 1843-44 1
Vermicularia pellucida (Broderip & Sowerby, 1829) 1,4

Family Caecidae

Caecum clathratum Carpenter, 1857 * 1,2,4
C. firmatum C. B. Adams, 1852 * 2
C. laqueatum C. B. Adams, 1852 * 6
C. mirificum DeFolin, 1867 * 2,4
C. quadratum Carpenter, 1857 2,4
C. richthofeni Strong & Hertlein, 1939 * 1,2
C. semilaeve Carpenter, 1857 * 1
C. undatum Carpenter, 1857 * 1,2,4
Elephantanellum heptagonum (Carpenter, 1857) * 2
Elephantulum insculptum (Carpenter, 1857) * 5
Fartulum dextroversum (Carpenter, 1857) * 3
F. laeve (C. B. Adams, 1852) * 1
F. farcimen (Carpenter, 1857) * 2,4

Family Modulidae

- Modulus cerodes* (A. Adams, 1851) * 2
M. disculus (Philippi, 1846) * 2

Family Vermetidae

- Serpulorbis margaritaceus* (Chenu, 1844) * 3,5

Family Cerithiidae

- Cerithium gemmatum* Hinds, 1844 2
C. adustum Kiener, 1841 4
C. menkei Carpenter, 1857 1
Cerithiopsis adamsi Bartsch, 1911 * 1,2,4
C. perrina Hertlein & Strong, 1951 * 1
Eumetula bimarginata (C. B. Adams, 1852) * 1,2
Metaxia convexa (Carpenter, 1857) * 1,2,4
Seila assimilata (C. B. Adams, 1852) 1,2,4
S. kanoni DeFolin, 1867 1,2
S. pulmoensis DuShane & Draper, 1975 * 1,2
Alaba interruptilineata Pilsbry & Lowe, 1932 * 1,2,7
A. excurvata (Carpenter, 1857) * 6
Alabina veraguensis Strong & Hertlein, 1939 * 1

Family Triphoridae

- Triphora alternata* C. B. Adams, 1852, * 1,2,4
T. chathamensis Bartsch, 1907 * 2
T. excolpa Bartsch, 1907 * 1,2
T. galapagensis Bartsch, 1907 * 1,4
T. hannai Baker, 1926 * 2
T. inconspicua C. B. Adams, 1852 * 1
T. postalba Bartsch, 1907 * 1,2,6
T. vanduzeei Baker, 1926 * 1,4

Family Strombidae

- Strombus granulatus* Swainson, 1822 2
S. galeatus Swainson, 1823 1
S. peruvianus Swainson, 1823 1

Family Epitoniidae

- Epitonium acapulcanum* Dall, 1917 1,2,3,4,5
E. billeanum (DuShane & Bratcher, 1965) 1,2
E. canna Dall, 1919 3
E. eutaenium (Dall, 1917) 1
E. minuticostatum (DeBoury, 1912) 1
E. reflexum (Carpenter, 1856) * 1
E. replicatum (Sowerby, 1844) 1
E. callipeplum Dall, 1919 * 3,5
E. hancocki DuShane, 1970 * 1
E. supracriatum Carpenter, 1857 3
E. politum (Sowerby, 1844) 1,3
E. willetti Strong & Hertlein, 1937 * 4
Amaea deroyae DuShane, 1970 1,4
Opalia crenatoides (Carpenter, 1864) 4,5
O. paulula DuShane, 1974 * 1
O. spongiosa Carpenter, 1864 1,2

Family Eulimidae

- Eulima elegantissima* DeFolin, 1867 * 1,2,4
E. hemphilli (Bartsch, 1917) * 2
E. townsendi (Bartsch, 1917) * 6
Balcis yod (Carpenter, 1857) * 2,3,4
Eulimostraca galapagensis Bartsch, 1917 * 1
Niso hipolitensis Bartsch, 1917 * 1,2
N. interrupta (Sowerby, 1834) 6
Scalenostoma rangii (DeFolin, 1867) * 2
Stilifer nidorum (Pilsbry, 1956) * 1
Thyca callista Berry, 1959 * 1,2

Family Hipponicidae

- Hipponix grayanus* Menke, 1853 2,4
H. panamensis C. B. Adams, 1852 3,4,5
H. pilosus (Deshayes, 1832) 4,5

Family Fossaridae

- Fossarus atratus* (C. B. Adams, 1852) * 1,3,4
Fossarus excavatus (C. B. Adams, 1852) * 1
F. tuberosus Carpenter, 1857 * 5
Macromphalina equatorialis (Pilsbry & Olsson, 1945) 1
M. symmetrica (Pilsbry & Olsson, 1945) 1,2,4

Family Vanikoridae

- Vanikoro aperta* (Carpenter, 1864) * 1,2

Family Calyptraeidae

- Calyptraea mamillaris* Broderip, 1834 7
Cheilea cepacea (Broderip, 1834) 1,2,4,7
Crepidula aculeata (Gmelin, 1791) 1,2,5
C. lessonii (Broderip, 1834) 3
C. onyx Sowerby, 1824 1,2,4
C. striolata Menke, 1851 * 2
Crepipatella dorsata (Broderip, 1834) 2,7
Crucibulum scutellatum (Wood, 1828) 2
C. spinosum (Sowerby, 1824) 4,7
C. subactum Berry, 1963 * 1

Family Capulidae

- Thyca callista* Berry, 1959 * 1,2

Family Naticidae

- Natica grayi* Philippi, 1852 6
N. idiopoma Pilsbry & Lowe, 1932 4
N. broderipiana Recluz, 1844 6
Eunaticina insculpta (Carpenter, 1865) 1,2
Polinices caprae (Philippi, 1852) 2
P. panamaensis (Recluz, 1844) 2
P. uber (Valenciennes, 1832) 6

Family Triviidae

- Trivia pacifica* (Sowerby, 1832) 1
T. atomaria Dall, 1908, 1,2,3
T. sanguinea (Sowerby, 1832) 1
Erato oligostata Dall, 1902 * 1,2
E. scabriuscula Sowerby, 1832 2

Family Cypraeidae

- Cypraea cervinetta* Kiener, 1843 1,2,4
C. arabicula (Lamarck, 1811) 1
C. nigropunctata Gray, 1828 1
C. robertsi (Hidalgo, 1906) 1
C. aequinoctialis (Schilder, 1933) 1

Family Ovulidae

- Cyphoma emarginatum* (Sowerby, 1830) 2
Simnia avena (Sowerby, 1832) 1
S. rufa (Sowerby, 1832) 2,6
Jenneria pustulata (Lightfoot, 1786) 2
Pseudocypraea adamsonii (Sowerby, 1832) * 1

Family Cassididae

- Cassidula tenuis* Wood, 1828 1
C. coarctata Sowerby, 1825 1
C. centiquadrata (Valenciennes, 1832) 1
Morum tuberculosum (Reeve, 1842) 1

Family Cymatiidae

- Cymatium lignarium* (Broderip, 1833) 1
- C. vestitum* (Hinds, 1844) 1
- Distorsio decussata* (Valenciennes, 1832) 1

Family Bursidae

- Bursa caelata* (Broderip, 1833) 1,2
- B. calcipicta* Dall, 1908 1

Family Colubrariidae

- Colubraria lucasensis* Strong & Hertlein, 1937 1
- C. procera* (Sowerby, 1832) * 1

Family Muricidae

- Hexaplex regius* (Swainson, 1821) 1
- Homalocantha oxyacantha* (Broderip, 1833) 1,2
- Murexiella exigua* (Broderip, 1833) 2
- M. vittata* (Broderip, 1833) 2
- Muricanthus princeps* (Broderip, 1833) 1
- M. radix* (Gmelin, 1791) 1
- Muricopsis zeteki* Hertlein & Strong, 1951 2
- Pterynotus pinniger* (Broderip, 1833) 2
- Aspella pyramidalis* (Broderip, 1833) 1
- A. pollux* Radwin & D'Attilio, 1976 * 1,2,4
- Bizetiella micaela* Radwin & D'Attilio, 1972 * 1,2
- B. shaskyi* Radwin & D'Attilio, 1972 * 1,2
- Eupleura muriciformis* (Broderip, 1833) 8
- Evoksia ferruginosa* (Reeve, 1846) * 1
- E. rufonotata* (Carpenter, 1864) * 1
- Favartia erosa* (Broderip, 1833) * 1,2,4,5
- F. incisa* (Broderip, 1833) 2
- Phyllocoma scalariformis* (Broderip, 1833) 1,2
- Trachypollia lugubris* (C. B. Adams, 1852) * 1,2,4
- Vitularia salebrosa* (King & Broderip, 1832) * 1
- Trophon sentus* (Berry, 1969) * 2

Family Coralliophilidae

- Coralliophylla costata* (Blainville, 1832) * 1
- C. orcuttiana* Dall, 1919 * 1
- C. parva* (E. A. Smith, 1877) 1,2
- Latiaxis hindsii* Carpenter, 1857 * 2

Family Thaididae

- Thais callaoensis* (Gray, 1828) 1,4
- T. speciosa* (Valenciennes, 1832) 4
- T. triangularis* (Blainville, 1832) 1,4
- R. biserialis* (Blainville, 1832) 1,4
- T. delessertiana* (Orbigny, 1841) 1
- T. planospira* (Lamarck, 1822) 1
- T. melones* (Duclos, 1832) 1
- Acanthina brevidentata* (Wood, 1828) 1
- Purpura columellaris* (Lamarck, 1822) 1
- P. pansa* Gould, 1853 1
- Neorapana muricata* (Broderip, 1832) 1

Family Buccinidae

- Caducifer biliratus* (Reeve, 1846) 1,2
- C. crebristriatus* (Carpenter, 1856) * 1,2
- C. nigricostatus* (Reeve, 1836) * 1,2
- Cantharus gemmatus* (Reeve, 1846) 4
- C. ringens* (Reeve, 1846) 1
- C. vibex* (Broderip, 1833) * 2
- Solenosteira mendozana* (Berry, 1959) 6

- Engina mantensis* (Bartsch, 1928) 1,2
- E. maura* (Sowerby, 1832) 2,4
- E. pulchra* (Reeve, 1846) 2,4
- E. tabogaensis* Bartsch, 1931 * 1,2,4
- Northis pristiis* (Deshayes, in Lamarch, 1844) 8
- Phos cumingii* Reeve, 1846 6

Family Columbelloidea

- Columbella fuscata* Sowerby, 1832 1,4
- C. haemastoma* Sowerby, 1832 1
- C. labiosa* Sowerby, 1822 1,4
- C. sonsonatensis* (Mörch, 1860) * 1
- C. strombiformis* Lamarck, 1822 4
- Aesopus sanctus* Dall, 1919 * 1,2,4
- Anachis coronata* (Sowerby, 1832) * 1,2
- A. fluctuata* (Sowerby, 1832) 4
- A. rugulosa* (Sowerby, 1844) 1,4
- A. dalli* Bartsch, 1931 * 4
- A. mullineri* Poorman, 1983 * 2,4
- A. pardalis* (Hinds, 1843) * 1,4
- A. incerta* (Stearns, 1892) 1,4
- Cosmioconcha palmeri* (Dall, 1913) * 1,6
- Mazatlanica fulgurata* (Philippi, 1846) * 7
- Microcithara uncinata* (Sowerby, 1832) * 1,2
- Mitrella delicata* (Reeve, 1859) * 1,4
- M. elegans* (Dall, 1871) 4,5
- M. guttata* (Sowerby, 1832) * 3
- M. harfordi* Strong & Hertlein, 1937 * 1
- M. santabarbaraensis* (Gould & Carpenter, 1857) * 1,3,4
- Nassarina vespera* Keen, 1971 * 1
- N. helenae* Keen, 1971 * 1,2
- N. melanosticta* (Pilsbry & Lowe, 1932) * 2
- N. tinctoria* (Carpenter, 1864) * 1,2
- N. atella* Pilsbry & Lowe, 1932 * 1
- N. conspicua* (C. B. Adams, 1852) * 2,4,5
- N. whitei* (Bartsch, 1928) 1,2,4
- Parametaria marcostoma* (Reeve, 1858, ex Anton MS) * 1,2
- Strombina gibberula* (Sowerby, 1832) 6
- S. maculosa* (Sowerby, 1832) * 1,2
- S. recurva* (Sowerby, 1832) 4

Family Nassariidae

- Nassarius angulicostis* (Pilsbry & Lowe, 1932) * 1,2
- N. corpulentus* (C. B. Adams, 1852) 1,2
- N. gemmulosus* (C. B. Adams, 1852) * 6
- N. limacinus* (Dall, 1917) * 6
- N. taeniolatus* (Philippi, 1845) 2
- N. versicolor* (C. B. Adams, 1852) 2

Family Fasciolariidae

- Fasciolaria princeps* Sowerby, 1825 1
- Latirus concentricus* (Reeve, 1847) 1,2
- L. mediamericanus* Hertlein & Strong, 1951 2
- L. tumens* Carpenter, 1856 * 1
- Opeatostoma pseudodon* (Burrow, 1815) 1
- Fusinus dupetitthouarsi* (Kiener, 1840) 1

Family Volutidae

- Lyria barnesii* (Gray, 1825) 1,2

Family Olividae

- Oliva kaleontina* Duclos, 1835 1,2
- O. spicata* (Röding, 1798) 1,2
- O. splendidula* Sowerby, 1825 2
- O. undatella* Lamarck, 1810 7
- Agaronia testacea* (Lamarck, 1811) 8
- Olivella fletcheriae* Berry, 1858 * 1,2
- O. gracilis* (Broderip & Sowerby, 1829) * 1,2,6
- O. tergina* (Duclos, 1835) 2
- O. columellaris* (Sowerby, 1825) 7
- O. zanoeta* (Duclos, 1835) 7

Family Vasiidae

- Vasum caestus* (Broderip, 1833) 1

Family Marginellidae

- Prunum sapotilla* (Hinds, 1844) * 1
- Persicula imbricata* (Hinds, 1844) 3
- Granula insularum* Roth & Coan, 1971 * 1
- G. polita* (Carpenter, 1857) * 1,2,4

Family Mitridae

- Mitra crenata* Broderip, 1836 2
- M. lens* Wood, 1828 4
- M. sphoni* Shasky & Campbell, 1964 * 1
- M. tristis* Broderip, 1836 4
- Subcancilla erythrogramma* (Tomlin, 1931) * 2
- S. hindsii* (Reeve, 1844) 6
- Thala gratiosa* (Reeve, 1845) 2
- T. solitaria* (C. B. Adams, 1832) 2

Family Cancellariidae

- Cancellaria gemmulata* Sowerby, 1832 1
- C. urceolata* Hinds, 1843 1
- C. tessellata* Sowerby, 1832 1
- C. indentata* Sowerby, 1832 2
- C. pulchra* Sowerby, 1832 1,2
- C. chrysostoma* Sowerby, 1832 2
- C. mitriformis* Sowerby, 1832 6
- C. clavatulata* Sowerby, 1832 1,7
- Perplicaria clarki* M. Smith, 1947 * 4
- Trigonostoma breve* (Sowerby, 1832) 1,2
- T. elegantulum* M. Smith, 1947 * 1,2

Family Conidae

- Conus brunneus* Wood, 1828 4
- C. gladiator* Broderip, 1833 2,8
- C. purpurascens* Sowerby, 1833 1
- C. vittatus* Hwass, in Bruguière, 1792
- C. lucidus* Wood, 1828 1
- C. nux* Broderip, 1833 4
- C. tornatus* Sowerby, 1833 6

Family Terebridae

- Terebra argosyia* Olsson, 1971 1
- T. berryi* Campbell, 1961 * 6
- T. corintoensis* Pilsbry & Lowe, 1932 1
- T. crenifera* Deshayes, 1859 6
- T. hancocki* Bratcher & Burch, 1970 1,2
- T. intertincta* Hinds, 1844 1,2,6
- T. ninfiae* Campbell, 1961 * 6
- T. puncturosa* Berry, 1961 2,6
- T. sanjuanensis* Pilsbry & Lowe, 1932 * 6
- T. strigata* Sowerby, 1825 2

Family Turridae

- Agladrillia pudica* (Hinds, 1843) 6
- Drillia acapulcana* (Lowe, 1935) 1
- Cerodrillia cybele* (Pilsbry & Lowe, 1932) 1
- Iredalea ella* (Pilsbry & Lowe, 1932) * 1,2,4
- I. perfecta* (Pilsbry & Lowe, 1932) 1
- Crassispira cortezi* Shasky & Campbell, 1964 * 1,2
- C. discors* (Sowerby, 1834) 1
- C. epicasta* Dall, 1919 * 1,2
- C. rustica* (Sowerby, 1834) 1
- C. bifurca* (E. A. Smith, 1888) 2
- C. kluthi* E. K. Gordan, 1936 6
- C. xanti* Hertlein & Strong, 1951 6
- Carinodrillia alboangulata* (E. A. Smith, 1882) 2
- C. dichroa* Pilsbry & Lowe, 1932 1
- C. hexagona* (Sowerby, 1834) 2
- Strictispira stillmani* Shasky, 1971 * 1,2
- Compsodrillia duplicata* (Sowerby, 1834) 1
- Pilsbryspira aterrima* (Sowerby, 1834) 4
- P. collaris* (Sowerby, 1834) 2
- P. bacchia* (Dall, 1919) * 2
- Mitromorpha carpenteri* Gilbert, 1954 1
- Nannodiella fraternalis* (Dall, 1919) * 1
- N. nana* (Dall, 1919) * 1,6
- Kurtziella antiochroa* (Pilsbry & Lowe, 1932) 2
- K. cyrene* (Dall, 1919) 6
- Glyptaesopus xenicus* (Pilsbry & Lowe, 1932) * 1,3,6
- Tennaturris merita* (Hinds, 1843) 2,3
- Notocytharella striosa* (C. B. Adams, 1852) 6
- Euclathurella acclivicalis* McLean & Poorman, 1971 * 2 (I also have a specimen of this species from Guaymas, Mexico)
- E. carissima* (Pilsbry & Lowe, 1932) * 6
- Platycythara electra* (Dall, 1919) * 1
- Kurtzia elenensis* McLean & Poorman, 1971 6
- K. granulatissima* (Mörch, 1860) * 1,2
- Agathotoma alcippe* (Dall, 1918) 2
- A. finitima* (Pilsbry & Lowe, 1932) 2
- A. klasmidia* Shasky, 1971 * 1
- Pyrgocythara helena* (Dall, 1919) * 1,2,4,6
- Ithyocythara penelope* (Dall, 1919) 1
- Daphnella mazatlanica* Pilsbry & Lowe, 1932 1,2,4
- D. retusa* McLean & Poorman, 1971 * 1
- Philbertia doris* Dall, 1919 * 1,2,4
- Microdaphne trichodes* (Dall, 1919) 1,2,4

Family Pyramidellidae

- Pyramidella elenensis* Bartsch, 1924 1
- P. hastata* (A. Adams & Sowerby, 1853) * 1
- P. clavulus* (A. Adams, in Sowerby, 1854) * 1,4
- Odostomia mammillata* Carpenter, 1857 * 4
- O. (Chrysallida) collea* Bartsch, 1926 1,2,4
- O. (C.) excelsa* Dall & Bartsch, 1909 * 4
- O. (C.) olssoni* Bartsch, 1924 4
- O. (C.) salinasensis* Bartsch, 1928 1,2,4
- O. (Egila) poppei* Dall & Bartsch, 1909 * 4
- O. (Iolaea) amianta* Dall & Bartsch, 1907 * 2
- O. (I.) delicatula* Carpenter, 1864 * 4
- O. (Ividella) navisa* Dall & Bartsch, 1907 * 4
- O. (I.) notabilis* (C. B. Adams, 1852) * 4
- O. (Menestho) callipyrga* Dall & Bartsch, 1904 * 1,4
- O. (Miralda) armata* Carpenter, 1857 * 1,2,4
- O. (M.) exarata* Carpenter, 1857 * 2

- O. (M.) terebellum* (C. B. Adams, 1852) * 1,2
O. (Pyrgulina) marginata (C. B. Adams, 1852) * 2,4
Peristichia pedroana (Dall & Bartsch, 1909) * 2
Triptychus olssoni (Bartsch, 1926) 2,4
Turbonilla (Asmunda) turrita (C. B. Adams, 1852) * 2
T. (Bartschella) vestae Hertlein & Strong, 1951 * 2,4
T. (Chemnitzia) theone Bartsch, 1924 3,4,5
T. (Cingulina) evermanni Baker, Hanna & Strong, 1928 * 1,2
T. (C.) urdeneta Bartsch, 1917 * 6
T. (Dunkeria) andrewsi Dall & Bartsch, 1909 * 2
T. (Strioturbonilla) nychia Bartsch, 1924 1

Family Bullidae

- Bulla gouldiana* Pilsbry, 1895 4
B. punctulata A. Adams, in Sowerby, 1850 1,2

Family Atyidae

- Atys casta* Carpenter, 1864 * 1,6
Haminoea virescens (Sowerby, 1833) * 2

Family Retusidae

- Sulcoretusa paziana* (Dall, 1919) * 6
Volvulella panamica Dall, 1919 * 1

Family Scaphandridae

- Acteocina angustior* Baker & Hanna, 1927 * 6
Cylichna laticola (C. B. Adams, 1852) * 1
Cylichnella zeteki Bartsch, 1918 * 6

Family Cavoliniidae

- Cavolinia longirostris* (Blainville, 1821) 1
C. uncinata (Rang, 1829) 1

Family Volvatellidae

- Ascobulla japonica* (Hamatani, 1969) * 1

Family Juliidae

- Julia thecaphora* (Carpenter, 1857) 1,2

Family Melampidae

- Pedipes angulatus* C. B. Adams, 1852 1
P. liratus Binney, 1860 * 3

Family Siphonariidae

- Siphonaria maura* Sowerby, 1835 1
S. palmata Carpenter, 1857 1,3
Williamia peltoides (Carpenter, 1864) 1,6

Family Trimusculidae

- Trimusculus stellatus* (Sowerby, 1835) * 1,4

Family Chitonidae

- Chiton stokesii* Broderip, 1832 1,3,4

Family Acanthochitonidae

- Acanthochitona avicula* (Carpenter, 1864) 2,4,5
A. hirudiniformis (Sowerby, 1832) 1,3

Family Ischnochitonidae

- Ischnochiton dispar* (Sowerby, 1832) 5
Stenoplax limaciformis (Sowerby, 1832) 1,4,5
Callistochiton elenensis (Sowerby, 1832) 4,5

Family Dentaliidae

- Dentalium tesseragonum* Sowerby, 1832 6
Fusataria innumerabilis (Pilsbry & Sharp, 1897) 1

Family Siphonodentaliidae

- Siphonodentalium quadrifissatum* (Pilsbry & Sharp, 1898) * 1
Cadulus perpusillus (Sowerby, 1832) 6
C. austinclarki Emerson, 1951 6

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**MARINE MOLLUSKS OF COCOS ISLAND,
COSTA RICA
I. BIBLIOGRAPHIC COMPILATION
OF SPECIES**

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An annotated check-list is presented of the marine mollusk species previously reported from Cocos Island, Costa Rica (5°32'57"N; 86°59'17"W). It includes 118 species: 16 Pelecypoda, 89 Gastropoda, 4 Polyplacophora, and 9 Cephalopoda. The nomenclature and synonymy of each species is noted, as are existing historical records and relevant geographic and ecological information. There is also a list of five species cited for the island, but presence of which is doubtful (3 Gastropoda and 2 Cephalopoda).

In 1978 the government of Costa Rica decided to incorporate Isla del Coco (5°32'57"N; 86°59'17"W) into its system of parks and national reserves. Accordingly, the Servicio Nacional de Parques of Costa Rica began a series of studies of the islands biological and scenic resources in order to develop and put into action a management plan for this national park.

At the same time the government of Costa Rica petitioned the United Nations Educational, Scientific, & Cultural Organization (UNESCO) to designate the park a World Heritage Site. Such recognition would allow the focusing of technical, scientific and financial resources that would guarantee the integrity, conservation, and adequate management of Isla del Coco for the future. Moreover, the designation of a World Heritage Site requires the preparation of studies that justify its unique and exceptional character.

This bibliographic list of marine mollusks is the first part of a series on the malacological fauna of Isla del Coco. It should be considered a contribution to the national park service of Costa Rica as an aid to establishing a management program for the island, and as partial documentation of the unique and exceptional character, on a worldwide basis, of the marine fauna of this island.

In preparing this species list from Cocos Island, various partial or complete lists have been used, notably those of Dall (1900, 1902, 1908), Pillsbury & Vanatta (1902), von Martens (1902), Biolley (1907, 1935), Tomlin (1927, 1928), Hertlein (1932, 1937, 1963), and Emerson & Old (1964). Corrections and additions to these works have been published in the eastern Pacific

faunal studies of Keen (1958, 1971), and Keen & Coan (1975), and in monographs by specialists on specific taxonomic groups: Grau (1959) on Pectinidae; Ingram (1945, 1947, 1948, 1951) and Schilder & Schilder (1938) on Cypraeidae; Radwin & D'Attilio (1976) on Muricidae; Hanna & Strong (1949) and Walls (1978) on Conidae; Howard (1952) on Pteropoda; Robson (1929, 1932, 1948) on Cephalopoda. Finally, all the literature available on the malacological fauna related to Isla del Coco has been analyzed.

For each species documented from this island, the following data are presented:

(a) Name of the species according to the nomenclature of Keen (1971) and Keen & Coan (1975), indicated genus, subgenus (if appropriate), and the species. A subspecies is indicated only if it is in use. When the species is not reported in Keen (1971) or Keen & Coan (1975), the nomenclature of the author of the species is used, or that of the author who reported its presence on the island is used. The species name also includes author and date of first publication.

(b) Following the species name are citations of the authors who have reported the species from the island, using the nomenclature employed in their reports. The reference includes the year of publication and the page(s) on which the reference appears.

(c) If the island is the type locality, or if material collected here was designated as a holotype or paratype, it is indicated next.

(d) Finally, the geographic distribution and comments on the ecology of the species are presented.

This format is designed to allow an analysis of the origin and composition of the marine molluscan fauna of the island, which will be presented in a later communication of this series.

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PELECYPODA

ARCIDAE

Anadara (Esmerarca) reinharti (Lowe, 1935)

Anadara (Scapharca) reinharti: Rost, 1955: 227

Arca (Anadara) reinharti: Hertlein, 1963: 237

Emerson & Old, 1964: 91

This species occurs from Puerto Peñasco in the Gulf of California to Ecuador, in depths of 2 to 91 m.

Anadara (Grandiarca) grandis (Broderip & Sowerby, 1829)

Arca (Anadara) grandis: Emerson & Old, 1964: 91

Its distribution is from Bahía Magdalena, on the Pacific coast of Baja California, through the Gulf of California to Tumbes, Peru. It is found in sandy areas along the low tide line.

LIMOPSIDAE

Limopsis dalli Lamy, 1912

Limopsis compressus Dall, 1896 (*non* Nevill, 1874):
Dall, 1908: 394

Knudsen (1970) established the synonymy of *L. dalli* and *L. compressus*. The distribution of this species is from west Mexico to the Gulf of Panama.

GLYCYMERIDAE

Glycymeris (Tucetona) multicostata (Sowerby, 1833)
Dall, 1908: 399

It is distributed from Punta Peñasco, Sonora, Mexico, to Guayaquil, Ecuador, in depths to 90 m.

MYTILIDAE

Crenella divaricata (Orbigny, 1846)

Soot-Ryen, 1955: 130

Hertlein, 1963: 237

Occurs from southern California, throughout the Gulf of California, and south to Peru, in depths of 4 to 450 m.

Lithophaga (Labis) attenuata attenuata (Deshayes, 1836)

Bartsch & Rehder, 1939: 18

Hertlein, 1963: 238

Keen (1971: 68) recognized two subspecies: *L. attenuata attenuata* is lighter and occurs from Costa Rica to Chile; *L. a. rogersi* is heavier and occurs from southern California to southern Mexico.

Lithophaga (Myoforceps) aristata (Dillwyn, 1817)

Soot-Ryen, 1955: 141

Turner & Boss, 1963: 108

Hertlein, 1963: 138

This species is widely distributed, from west Africa to the West Indies, the Mediterranean Sea, the Red Sea, Australia and Japan; and from southern California to Peru. It is found from the intertidal zone to 400 m zone.

ISOGNOMONIDAE

Isoognomon recognitus (Mabille, 1895)

Perna "quadrangularis": von Martens, 1902: 138
Pilsbry & Vanatta, 1902: 137

Biolley, 1907: 25

Perna "chemnitziana": Pilsbry & Vanatta, 1902: 559

Melina "chemnitziana": Dall, 1908: 437

Pedalion "chemnitzianum": Hertlein, 1932: 45

Isoognomon (Melina) "chemnitzianum": Hertlein, 1963: 237

Isoognomon "quadrangularis": Hertlein, 1963: 238

Emerson & Old, 1964: 91

Keen (1971: 80) states that *I. chemnitzianum* and *I. quadrangularis* are not the same species. *Isoognomon quadrangularis* is a related Japanese form, and the true *I. chemnitziana* is Caribbean. The distribution of this species is from northern Baja California to Chile.

OSTREIDAE

Ostrea iridescens Hanley, 1854

Emerson & Old, 1964: 91

The distribution of this species is from La Paz in the Gulf of California to northern Peru, on rocks in the intertidal zone.

Ostrea palmula Carpenter, 1857

Hertlein, 1963: 238

Emerson & Old, 1963: 91

This species is found from La Laguna San Ignacio, Baja California, throughout the Gulf of California, to Ecuador and the Galápagos Islands. It is found on mangrove plants and on rocks exposed to the tides, to depths of 7 m.

PECTINIDAE

Pecten (Flabellipecten) sericeus Hinds, 1845

Olsson, 1961: 160

Pecten (Pecten) sericeus: Hertlein, 1935: 303

Hertlein & Strong, 1946: 56

Grau, 1959: 142

Hertlein, 1963: 238

Pecten sericeus: Dall, 1908: 400

The distribution of this species is from Isla Angel de la Guarda, Gulf of California, to Caleta de la Cruz, Peru, including the Galápagos Islands.

Pecten (Oppenheimopecten) hancocki Grau, 1959

Grau, 1959: 155

Hertlein, 1963: 238

Keen, 1971: 87

The type locality for this species is Cocos Island, in 86 m; it is restricted to this island.

Cyclopecten cocosensis (Dall, 1908)

Keen, 1971: 89

Pecten (Cyclopecten) cocosensis: Dall, 1908: 405

Hertlein, 1935: 319

Keen, 1958: 72

Grau, 1959: 30

Hertlein, 1963: 238

The type locality for this species is Cocos Island. Its distribution extends to the Gulf of Panama in 95 to 113 m.

Cyclopecten exquisitus Grau, 1959

Pecten (Cyclopecten) exquisitus: Hertlein, 1963: 238

The geographic distribution of this species extends from Isla Angel de la Guarda in the Gulf of California to Callao in Peru; it includes the Galápagos Islands. This species is found in 22 to 274 m.

Lyropecten (Nodipecten) subnodosus (Sowerby, 1835).

Pecten (Nodipecten) subnodosus: Dall, 1908: 401

Pecten nodosus subnodosus: Smith, 1944: 52

Its distribution is from Scammon's Lagoon in Baja California to Peru.

POROMYIDAE

Poromya (Cetoconcha) scapha (Dall, 1901)

Keen, 1971: 298

Cetoconcha scapha: Dall, 1902: 561

Hertlein, 1963: 237

The type locality for this species is Cocos Island; its distribution extends to the Gulf of Panama, in 183 m.

GASTROPODA

HALIOTIDAE

Haliotis (Padollus) roberti McLean, 1970

McLean, 1970: 115

Keen, 1971: 309

Abbott, 1974: 18

The type locality of this species is Cocos Island which is the only locality from which it has been collected. The single specimen was collected in 1938 from between 73 to 86 m.

FISSURELLIDAE

Fissurella (Cremides) virescens Sowerby, 1835

von Martens, 1902: 137

Pilsbry & Vanatta, 1902: 559

Biolley, 1907: 23

Tomlin, 1928: 188

Hertlein, 1932: 45

Hertlein, 1963: 239

The distribution of this species extends from Mazatlán, Mexico, to Islas de Lobos in Peru, including the Galápagos Islands. It is found on rocks in the intertidal zone.

ACMAEIDAE

Collisella strigatella (Carpenter, 1864)

Pilsbry & Vanatta, 1902: 559

Hertlein, 1963: 238

This species is distributed from Cabo San Lucas, Baja California Sur, and in the Gulf of California north of Loreto and Guaymas. It is found on rocky faces in the intertidal zone in areas partially protected from waves.

Scurria mesoleuca (Menke, 1851)

Pilsbry & Vanatta, 1902: 559

Acmaea striata (Reeve, 1855): von Martens,

1902: 137

Biolley, 1907: 23

Hertlein, 1937: 306

Collisella mesoleuca: Tomlin, 1928: 188

? *Acmaea (Collisella) aeruginosa*: Hertlein, 1932: 45.

Acmaea (Nomaepelta) mesoleuca:

Hertlein, 1963: 238

Emerson & Old, 1964: 91

The distribution of this species is from Cerralvo Island to Cabo San Lucas, Baja California Sur, and from Mazatlán, Mexico, to the peninsula of Santa Elena and the Galápagos Islands, Ecuador.

TROCHIDAE

Bathymbelix (Solaricida) equatorialis (Dall, 1908)

Solariella equatorialis: Dall, 1908: 352

One of the paratypes of this species was collected on Cocos Island. This species is distributed from San Diego, California, to Panama, in depths of 1,830 to 2,190 m.

Mirachelus galapagensis McLean, 1970

McLean, 1970: 118

Keen, 1971: 331

This species has a distribution restricted to the Galápagos Islands and to Cocos Island in 91 to 183 m. *Solariella diomedea* Dall, 1919

Keen, 1971: 331

This species is distributed from Cocos Island to the Galápagos Islands in 37 to 128 m.

Tegula (Agathistoma) cooksoni (E. A. Smith, 1877)

Tomlin, 1928: 187

Hertlein, 1963: 241

Its distribution is restricted to the Galápagos Islands and Cocos Island, on rocks in the intertidal zone.

Tegula (Agathistoma) maculostraiata (Adams, 1845)

Hertlein, 1963: 241

McLean, 1969: 122

Keen, 1971: 338

Chlorostoma maculostratum:

Pilsbry & Vanatta, 1902: 559

Biolley, 1907: 26

This species belongs to the malacological fauna of the Caribbean. Cocos Island is the only locality in the eastern Pacific where it has been collected.

LITIIDAE

Arene (Arene) ferruginosa McLean, 1970

McLean, 1970: 123

Keen, 1971: 346

This species occurs from north of Acapulco, Mexico, to Bahía Honda, Panama. Dwarf specimens have been collected in the Galápagos Islands and at Cocos Island. It has been brought up from 46 to 91 m.

TURBINIDAE

Turbo (Callopona) saxosus Wood, 1828

Dall, 1908: 341

This species is distributed from San Juan del Sur, Nicaragua, to Paíta, Peru, occurring in rocky areas at the low tide level.

NERITIDAE

Nerita (Ritena) scabricosta Lamarck, 1822

Dall, 1908: 437

Nerita ornata Sowerby, 1823:

von Martens, 1902: 137

Biolley, 1907: 23

Hertlein, 1963: 240

Emerson & Old, 1964: 91

Nerita scabricosta var. *ornata*: Hertlein, 1932: 45.

The species is distributed from Punta Pequeña, Baja California, to Ecuador, and is found on rock surfaces in areas splashed by waves at high tide.

Nerita (Theliostyla) funiculata Menke, 1851

Hertlein, 1963: 240

Emerson & Old, 1964: 91

Nerita bernhardi Récluz, 1855:

von Martens, 1902: 137

Biolley, 1907: 23

Hertlein, 1932: 45

Nerita fulgurans bernhardi:

Pilsbry & Vanatta, 1902: 559

This species is distributed from Baja California, through the Gulf of California to Peru, including the Galápagos Islands. It is located on rocks in the intertidal zone.

Neritina (Clypeolum) latissima Broderip, 1833

Emerson & Old, 1964

Neritina latissima var. *globosa*

Broderip 1833; Biolley, 1907: 18

Neritina pilsbryi Tryon, 1888: Hertlein, 1932: 45

Hanna & Hertlein, 1938: 125

Hertlein, 1963: 240

It occurs from Acapulco, Mexico, to Guayaquil, Ecuador. It is found in currents of water at river mouths and in pools at the high tide line.

LITTORINIDAE

Littorina aspera Philippi, 1846

von Martens, 1902: 137

Emerson & Old, 1964: 91

Littorina aspersa: Biolley, 1907: 23

Hertlein, 1932: 45

Hertlein, 1963: 239

This species is distributed from Laguna Manuela, Baja California, throughout the Gulf of California and south to Ecuador; it may occur in northern Peru.

Littorina modesta Philippi, 1846

Tomlin, 1927: 168

Hertlein, 1963: 239

Littorina conspersa Philippi, 1847:

von Martens, 1902: 137

Biolley, 1907: 22

Dall, 1908: 437

Hertlein, 1932: 45

Hertlein, 1963: 239

The distribution of this species is from Enseñada, Baja California, to Ecuador.

Littorina planaxis Philippi, 1847

Keen, 1971: 366

A California province species with a southern limit at Isla Socorro; Keen reported one lot from Cocos Island.

VERMETIDAE

Petalconchus (Macrophragma) complicatus Dall, 1908

Dall, 1908: 326

Keen, 1971: 403

This species has Isla del Coco as its type locality; a white color form has been collected in the Galápagos Islands: 110 to 275 m.

CERITHIIDAE

Cerithium (Theridium) adustum Kiener, 1841

von Martens, 1902: 137

Biolley, 1907: 22

Hertlein, 1932: 45

Hertlein, 1963: 239

Emerson & Old, 1964: 91

This species is distributed from Mazatlán, Mexico, to Ecuador, including the Galápagos Islands. It occurs on sandy substrates near rocks in the low tide zone, and in tide pools formed by high tide.

Cerithium (Theridium) maculosum Kiener, 1841

Pilsbry & Vanatta, 1902: 559

Dall, 1908: 437

Hertlein, 1963: 239

Its range of distribution reaches from Bahía Magdalena in Baja California, throughout the Gulf of California, to Mazatlán, including the Islas Tres Marias.

PLANAXIDAE

Planaxis planicostatus Sowerby, 1825

Hertlein, 1932: 45

Hertlein, 1963: 240

Emerson & Old, 1964: 91

von Martens, 1902: 137

Pilsbry & Vanatta, 1902: 559

Biolley, 1907: 22

Tomlin, 1927: 168

Planaxis planaxis (Wood, 1928): Dall, 1908: 437

Its distribution is from Mazatlán, Mexico, to Peru, and is found on rocks near the high tide line.

HIPPONICIDAE

Hipponix grayanus Menke, 1853

Biolley, 1907: 23

Hertlein, 1932: 32

Hertlein, 1963: 239

Emerson & Old, 1964: 91

Amalthea grayana: Pilsbry & Vanatta, 1902: 559

This species is distributed from Mazatlán, Mexico, to Ecuador.

Hipponix pilosus (Deshayes, 1832)

Hertlein, 1963: 239

Emerson & Old, 1964: 91

Hipponix barbatus Sowerby, 1835: von Martens, 1902: 137

It is distributed from the Gulf of California to Ecuador.

NATICIDAE

Polinices (Polinices) helicoides (Gray, 1825)

Hertlein, 1963: 240

? *Polinices glabella*: Tomlin, 1927: 170

This species occurs from Bahía Magdalena, outer coast of Baja California, throughout the Gulf of California, to Callaco, Peru. It is found from the low tide zone to 37 m.

Polinices pardoanus Dall, 1908

Dall, 1908: 336

Paratypes of this species come from Isla del Coco. Its distribution extends from the Gulf of Panama to the Galápagos Islands, and it occurs in 1,620 to 2,690 m.

TRIVIIDAE

Trivia (*Niveria*) *pacifica* (Sowerby, 1832)

Tomlin, 1927: 166

Hertlein, 1963: 241

Its distribution is from Punta Pescadero, Baja California, through the southern Gulf of California, to Marcora, Peru. The Galápagos Islands are its type locality.

CYPRAEIDAE

Cypraea (*Erosaria*) *albuginosa* Gray, 1825

Emerson & Old, 1964: 91

Keen, 1971: 492

It has a discontinuous distribution: from the center part of the Gulf of California to Manzanillo, Mexico, and from Panama to Ecuador, including the Galápagos and Cocos Islands.

Cypraea (*Luria*) *isabellamexicana* Stearns, 1893

Emerson & Old, 1964: 91

Cypraea "*isabella*": von Martens, 1902: 137

Biolley, 1907: 22

Cypraea controversa mexicana: Schilder, 1938: 176 and 197

Cypraea (*Luria*) "*isabella*": Demond, 1957: 304

Cypraea isabella mexicana: Hertlein, 1963: 239

Its distribution extends from Guaymas and La Paz in the Gulf of California, to Panama and the Galápagos Islands. This species is similar to the Indo-Pacific *Cypraea isabella* Linnaeus, 1758.

Cypraea (*Monetaria*) *moneta* Linnaeus, 1758

Hertlein, 1932: 45

Hertlein, 1937: 307

Ingram, 1947a: 58, 74

Ingram, 1947b: 147

Ingram, 1948: 140

Ingram, 1951: 152

Demond, 1957: 304

Hertlein, 1963: 239

Emerson & Old, 1964: 91

Keen, 1971: 493

Emerson, 1978: 93

This Indo-Pacific species has been collected on Clipperton, Cocos, and the Galápagos islands.

Cypraea (*Talostolida*) *rashleighana* Melvill, 1888

Ingram, 1945: 106

Ingram, 1947a: 76

Ingram, 1947b: 148

Ingram, 1951: 155

Hertlein, 1963: 239

Keen, 1971: 495

Emerson, 1978: 93

The only record of this Indo-Pacific species in the east Pacific is from Isla del Coco.

CASSIDIDAE

Cassis (*Semicassis*) *centiquadrata* (Valenciennes, 1832)

Emerson & Old, 1964: 91

This species is distributed from the Gulf of California to Lobitos, Peru; it has also been collected on the Galápagos Islands. It is found on sandy substrates in shallow depths.

Morum (*Cancellomorum*) *veleroae* Emerson, 1968

Emerson, 1968: 53

Keen, 1971: 503

Its distribution is between Isla del Coco and the Galápagos Islands in 55 to 90 m. The types of this species were collected at Cocos Island, in 1938.

CYMATIIDAE

Cymatium (*Septa*) *pileare* (Linnaeus, 1758)

Emerson & Old, 1964: 91

Emerson, 1978: 94

This species' distribution extends from the west Pacific to the east Atlantic; in the American Pacific it extends from Isla Cedros, Baja California, throughout the Gulf of California, to Panama.

Cymatium (*Septa*) *vestitum* (Hinds, 1844)

Hertlein, 1932: 45

Hertlein, 1963: 239

Emerson & Old, 1964: 91

Its distribution is from Manzanillo, Mexico, to Panama and the Galápagos Islands; possibly its range extends to northern Peru.

BURSIDAE

Bursa caelata (Broderip, 1833)

von Martens, 1902: 137

Biolley, 1907: 22

Hertlein, 1963: 238

Emerson & Old, 1964: 91

It ranges from the southern half of the Gulf of California to Peru, including Isla Socorro and the Galápagos Islands. It is found from the intertidal zone to several meters in depth on rocks and coral heads.

Bursa calcipicta Dall, 1908

Dall, 1908: 320

This species was described from specimens collected at Cocos Island by the Albatross Expedition in 1891. It is distributed from Bahía Tenacatita, Jalisco, Mexico, to La Plata, Ecuador; it is found from the intertidal zone to 120 m.

MURICIDAE

Murexiella humilis (Broderip, 1833)

Dall, 1908: 436

Hertlein, 1963: 240

The species is distributed from Sonora, Mexico, to Santa Elena, Ecuador. It is found from the intertidal zone to 33 m.

Aspella pollux Radwin & D'Attilio, 1976

Radwin & D'Attilio, 1976: 227

One of the paratypes of this species comes from Cocos Island. The distribution of this species extends from the extreme south of the Gulf of California to Costa Rica. It is found in 2 to 33 m.

THAIDIDAE

Thais (*Mancinella*) *speciosa* (Valenciennes, 1832)

Hertlein, 1963: 241

Emerson & Old, 1964: 92

It is distributed from Bahía Magdalena, Baja California, throughout the Gulf of California, to Peru. It is found on rocks in the intertidal zone.

Thias (*Mancinella*) *triangularis* (Blainville, 1832)

Hertlein, 1963: 241

Emerson & Old, 1964: 92

This species is distributed from Cabo San Lucas, Baja California, in the Gulf of California, to Peru. It is found in the rocky intertidal zone.

Thias (Stramonita) biserialis (Blainville, 1832)

Hertlein, 1932: 45

Thais haemastoma biserialis: Hertlein, 1963: 241

Emerson & Old, 1964: 92

The species is distributed from Isla Cedros, throughout the Gulf of California, to Chile. It occurs in the rocky intertidal zone.

Thais (Tribulus) planospira (Lamarck, 1822)

Emerson & Old, 1964: 92

It is distributed from Cabo San Lucas, throughout the Gulf of California, to Peru. It is found on rocks at the low tide line.

Thais (Vasula) melones (Duclos, 1832)

Hertlein, 1963: 241

Emerson & Old, 1964: 92

Purpura melo: von Martens, 1902: 137

Purpura melones: Pilsbry & Vanatta, 1902: 559

Thais melones: Dall, 1908: 436

Thais crassa: Hertlein, 1932: 45

This species is distributed from the Gulf of Tehuantepec, Mexico, to Callao, Peru. It has also been collected on the Galápagos Islands.

Acanthina brevidentata (Wood, 1828)

Hertlein, 1932: 45

Hertlein, 1963: 238

Emerson & Old, 1964: 91

Monoceros brevidentata: von Martens, 1902: 137

Monoceros brevidentatum: Biolley, 1807: 21

It is distributed from Mazatlán, Mexico, to Paita, Peru. Rocky intertidal zone.

Purpura columellaris (Lamarck, 1822)

von Martens, 1902: 137

Pilsbry & Vanatta, 1902: 559

Biolley, 1907: 21

Thais columellaris: Dall, 1908: 437

Hertlein, 1932: 45

Hertlein, 1963: 241

Emerson & Old, 1964: 91

It is distributed from the southern Gulf of California to Chile. It is found on rocks subject to wave action.

Purpura pansa Gould, 1853

Purpura patula, non Linnaeus, 1758:

von Martens, 1902: 137

Pilsbry & Vanatta, 1902: 559

Biolley, 1907: 21

Thais patula, non Linnaeus, 1758: Dall, 1908: 436

Tomlin, 1928: 163

Hertlein, 1932: 45

Purpura patula pansa: Hertlein, 1963: 241

Emerson & Old, 1964: 91

It is distributed from Bahía Magdalena, the southern Gulf of California, to Colombia and the Galápagos Islands. It is found on exposed rocks.

BUCCINIDAE

Caducifer (Monostiolum) cinis (Reeve, 1846)

Keen, 1971: 557

Pollia cinis: von Martens, 1902: 137

Biolley, 1907: 21

Tritonidea cinis: Pilsbry & Vanatta, 1902: 559

Caducifer thaleia Pilsbry & Lowe, 1932:

Keen, 1958: 398

From Jalisco, Mexico, to the Cocos and Galápagos Islands.

Cantharus (Gemophos) gemmatus (Reeve, 1846)

Hertlein, 1932: 45

Hertlein, 1963: 238

This species is distributed from Mazatlán, Mexico, to Ecuador, on intertidal rocks.

Cantharus (Gemophos) sanguinolentus (Duclos, 1833)

Pollia sanguinolenta haemastoma:

von Martens, 1902: 137

Biolley, 1907: 21

Tritonidea sanguinolenta:

Pilsbry & Vanatta, 1902: 559

Cantharus sanguinolentus: Hertlein, 1963: 238

It is distributed from the outer coast of Baja California, southern Gulf of California, to Ecuador. It is found around coral heads.

Phos (Metaphos) articulatus Hinds, 1844

Keen, 1971: 569

Phos cocosensis Dall, 1896: Dall, 1908: 306

Dall, 1917: 578

Strong & Lowe, 1936: 310

Keen, 1958: 406

Hertlein, 1963: 240

This most variable of the species of *Phos* ranges from Isla Tortuga, in the Gulf of California, to Isla Lobos, Peru, in 37 to 232 m. Its synonym was named from material collected on Cocos Island.

COLUMBELLIDAE

Columbella labiosa Sowerby, 1822

Hertlein, 1963: 241

Columbella labrosa: Pilsbry & Vanatta, 1902: 559

Biolley, 1907: 26

It is distributed from Nicaragua to Ecuador, on rocks exposed to wave action.

Mitrella guttata (Sowerby, 1832)

Columbella cribraria, non Lamarck, 1822:

Pilsbry & Vanatta, 1902: 559

Biolley, 1907: 26

Mitrella ocellata, non Gmelin, 1791:

Hertlein, 1963: 240

It occurs from Bahía Magdalena, throughout the Gulf of California, to Panama; under rocks in the intertidal zone.

FASCIOLARIIDAE

Leucozonia tuberculata (Broderip, 1833)

Laturus tuberculatus: Dall, 1908: 436

Hertlein, 1932: 45

Hertlein, 1963: 239

Its distribution is restricted to Cocos and the Galápagos Islands.

Fusinus allyni McLean, 1970

Keen, 1971: 617

The distribution of this species is restricted to Cocos and the Galápagos Islands, in 128 to 146 m.

HARPIDAE

Harpa crenata Swainson, 1822

Hertlein, 1932: 45

Hertlein, 1963: 239

It is distributed from Bahía Magdalena, the southern Gulf of California, to Isla Gorgona, Colombia.

TURBINELLIDAE

Surculina blanda (Dall, 1908)

Keen, 1971: 622

Daphnella (Surculina) blanda: Dall, 1908: 291

This species is the type for the genus, and Cocos Island is its type locality; known only from Cocos Island, at a depth of 1,953 m.

OLIVIDAE

Oliva (Oliva) spicata (Roding, 1798)

Emerson & Old, 1964: 91

This species is distributed from the Gulf of California to Panama.

Olivella (Olivella) cocosensis Olsson, 1956

Olsson, 1956: 180

Keen, 1958: 424

Hertlein, 1963: 240

Keen, 1971: 628

The type locality of this species is Cocos Island; it has also been reported from Nicaragua.

MARGINELLIDAE

Granula achenea Roth & Coan, 1971

Roth & Coan, 1971

Granula sp.: Keen, 1971: 636-638

It has only been collected from its type locality, Cocos Island, at 25 m.

Granula minor C. B. Adams, 1852

Marginella minor: Bartach & Rehder, 1939: 18

Hertlein, 1963: 240

Kogomea minor: Coan & Roth, 1966: 294

It is distributed from Puerto Parker, Costa Rica, to La Libertad and the Galápagos Islands, Ecuador. It occurs from the intertidal zone to 120 m.

MITRIDAE

Mitra (Atrimitra) fultoni E. A. Smith, 1892

Sphon, 1961: 35

Hertlein, 1963: 240

It is distributed from Santa Catalina Island, off Los Angeles, California (USA), to Puertecitos in the Gulf of California.

Mitra (Strigatella) lens Wood, 1828

Dall, 1908: 436

Hertlein, 1963: 240

It is distributed from the Gulf of California to Peru, in sand and under rocks at the low tide level.

Mitra (Strigatella) tristic Broderip, 1836

Hertlein, 1963: 240

From the northern end of the Gulf of California to Ecuador and the Galápagos Islands.

CANCELLARIIDAE

Cancellaria (Sveltia) centrota Dall, 1896

Keen, 1971: 654

Dall, 1908: 295

It occurs from Gorda Banks, Baja California Sur, to Cocos Island, its type locality, in 120 m.

CONIDAE

Conus (Conus) brunneus Wood, 1828

von Martens, 1902: 137

Biolley, 1907: 20

Tomlin, 1927: 155

Hanna & Strong, 1949: 269

Hertlein, 1963: 239

This species is distributed from Bahía Magdalena to Manta, Ecuador, intertidally and subtidally.

Conus (Conus) diadema pemphigus Dall, 1910

Hanna & Strong, 1949: 271

This subspecies is distributed from Islas Tres Marias, Nayarit, Mexico, to Cocos Island. It is found intertidally on rocks. (Keen, 1971: 661, places the subspecies in synonymy with *C. diadema* Sowerby, 1834.)

Conus (Conus) gladiator Broderip, 1833

Hertlein, 1963: 239

From Bahía Magdalena to Guaymas in the Gulf of California, to Ecuador and the Galápagos Islands, on rocky ledges intertidally.

Conus (Conus) tiaratus Sowerby, 1833

Hertlein, 1932: 45

Hanna & Strong, 1949: 272

Hertlein, 1963: 239

Emerson & Old, 1964: 91

Salvat & Ehrhardt, 1970: 229

Conus (Chelyconus) purpurascens Sowerby, 1833

Emerson & Old, 1964: 91

The species is distributed from Bahía Magdalena, throughout the Gulf of California, to Ecuador. In tide pools and on rocky ledges intertidally.

Conus (Cylinder) dalli Stearns, 1873

Hertlein, 1932: 45

Hertlein, 1937: 306

Hanna & Strong, 1949: 305

Hertlein, 1963: 239

Emerson & Old, 1964: 91

This species ranges from Guaymas, Mexico, to Panama and the Galápagos Islands.

Conus (Leptoconus) gradatus Wood, 1828

Dall, 1908: 254

It is distributed from the Gulf of California to Peru, especially common around in various depths.

Conus (Leptoconus) recurvus Broderip, 1833

Hertlein, 1963: 239

Conus scariphus Dall, 1910 (p. 225)

Tomlin, 1937: 306

Hanna & Strong, 1949: 280 (in synonymy)

Walls, 1978: 830 (in synonymy)

Conus scariphus was described by Dall (1910) based on material collected at Cocos Island; Hanna, Strong (1949) established the synonymy *C. scariphus* and *C. recurvus*. The species is distributed from Bahía Magdalena, Baja California Sur, and the Gulf of California, to Colombia, in 35 to 145 m.

TEREBRIDAE

Terebra berryi Campbell, 1961

Bratcher & Burch, 1971: 559

Keen & Coan, 1975: 37

It ranges from Puertecitos in the Gulf of California, to Costa Rica and Isla del Coco. It has been collected in 2 to 37 m.

Terebra maculata maculata (Linnaeus, 1758)

Bratcher, 1970: 6

Bratcher & Burch, 1971: 557

Keen, 1971: 680

Emerson, 1978: 93

Terebra maculata: Emerson & Old, 1964: 91

This western Pacific species has been collected in the eastern Pacific, only at Cocos Island.

TURRIDAE

Hindiscylava resina (Dall, 1908)

Turris (*Surcula*) *resina*: Dall, 1908: 264

This species was described from material collected at Cocos Island in 268 m. It occurs in the Gulf of Panama, Cocos Island, and Puerto Utria, Colombia.

Microdrillia zeuxippe (Dall, 1919)

Keen, 1971: 740

This species is known from the Galápagos and Cocos Islands in 20 to 110 m.

Glyphostoma (*Glyphostoma*) *scobina*

McLean & Poorman, 1971

Keen, 1971: 745

This species occurs from the Galápagos and Cocos Islands, in 90 to 200 m.

Xanthodaphne agonia (Dall, 1890)

Keen, 1971: 764

Pleorotomella (*Gymnobela*) *agonia* var. *altaina*

Dall, 1908: 279

A species from the Galápagos and Cocos Islands, in 1,159 to 1,850 m.

Xanthodaphne encella (Dall, 1908)

Keen, 1971: 764

Mangilia encella Dall, 1908: 214, 287

The only recorded locality for this species is from Isla del Coco, in 1,950 m.

BULLIDAE

Bulla (*Bulla*) *punctulata* A. Adams, in Sowerby, 1850

Emerson & Old, 1964: 91

This species occurs from Bahía Magdalena, and the Gulf of California, to Peru. It is found around the low tide line.

CAVOLINIIDAE

Cavolinia longirostris (Blainville, 1821)

Howard, 1952: 13

Hertlein, 1963: 242

This epipelagic species ranges from southern Mexico to Peru.

Crescis virgula (Rang, 1828)

Howard, 1952: 13

Hertlein, 1963: 242

This species is widely distributed worldwide in warm waters; in the American Pacific it occurs from Baja California to Peru.

Diacria quadridentata (Blainville, 1821)

Diacria quadridentata parva: Howard, 1952: 13

Hertlein, 1963: 242

This epipelagic species is distributed in the American Pacific from southern Mexico to Peru.

LIMACINIDAE

Limacina inflata (Orbigny, 1836)

Howard, 1952: 13

Hertlein, 1963: 242

This species is found in waters off Baja California, and from El Salvador to Peru.

MELAMPIDAE

Melampus (*Melampus*) *carolinianus* (Lesson, 1842)

Melampus trilineatus (C. B. Adams, 1852):

Hanna & Hertlein, 1938: 134

Hertlein, 1963: 240

Melampus (*Pira*) *tabogensis* C. B. Adams, 1852

von Martens, 1902: 137

Biolley, 1907: 24

Hanna & Hertlein, 1938: 134

Morrison, 1946: 36

Hertlein, 1963: 40

Keen, 1971: 846

This species is distributed from Barra de Navidad, Jalisco, Mexico, to Panama and has been collected at the Galápagos and Cocos Islands.

Tralia panamensis (C. B. Adams, 1853)

Dall, 1896: 452

Melampus panamensis: Dall, 1900: 97

von Martens, 1900: 561

Dall, 1908: 436

Hanna & Hertlein, 1938: 133

Hertlein, 1963: 240

This species is distributed from Costa Rica to Panama, including the Perlas Islands, under rocks at the high tide mark.

Ellobium stagnalis (Orbigny, 1835)

Hertlein, 1963: 239

Emerson & Old, 1964: 91

Auricula stagnalis: von Martens, 1902: 62

Biolley, 1907: 19

Hanna & Hertlein, 1938: 132

From El Salvador to Ecuador, on the trunks and roots of mangroves, near the high tide line.

SIPHONARIIDAE

Siphonaria (*Heterosiphonaria*) *gigas* Sowerby, 1825

Dall, 1896: 453

Dall, 1900: 97

von Martens, 1902: 137

Pilsbry & Vanatta, 1902: 559

Biolley, 1907: 25

Dall, 1908: 436

Dall, 1909: 205

Hertlein, 1932: 45

Siphonaria characteristic Reeve, 1856:

Tomlin, 1927: 154

Siphonaria gigas var. *characteristica*:

Hertlein, 1932: 45

Hanna & Hertlein, 1938: 125

Hertlein, 1963: 241

Emerson & Old, 1964: 91

The distribution of this species is from Acapulco, Mexico, to Peru, on rocks.

POLYPLACOPHORA

CHITONIDAE

Chiton goodallii Broderip, 1832

Boone, 1933: 201

Chiton (*Radsia*) *goodallii*: von Martens, 1902: 137

Hertlein, 1963: 243

Chiton (*Chiton*) *goodallii*: Boone, 1933: 24

This species has been collected only on the Galápagos and Cocos Islands.

Chiton stokesii Broderip, 1832

Dall, 1908: 437

Tomlin, 1927: 154

Chiton (Chiton) stokesii: Leloup, 1956: 246

Hertlein, 1963: 243

Emerson & Old, 1964: 92

Chiton (Radsia) stokesi: Biolley, 1907: 24

Chiton stokesi: Pilsbry & Vanatta, 1902: 559

It is distributed from southern Mexico to Ecuador, and is found on top of exposed rocks.

ACANTHOCHITONIDAE

Acanthochitona hirudiniformis (Sowerby, 1832)

Hertlein, 1963: 242

The range of distribution of this species is from Panama to Peru, possibly to Chile. It is found on rock surfaces.

MOPALIIDAE

Placiphorella blainvillii (Broderip, 1832)

Dall, 1908: 357

Dall, 1909: 246

Hertlein, 1963: 243

It is distributed from Panama to Peru, on top of rocky surfaces below the low tide line.

CEPHALOPODA

CRANCHIIDAE

Galiteuthis pacifica (Robson, 1948)

Keen & Coan, 1975: 50

Taonidium pacificum: Robson, 1948: 130

Hertlein, 1963: 243

The species is distributed from southern California to Panama and Cocos Island; depth data have not been reported.

Helicocranchia beebei Robson, 1948

Robson, 1948: 130

Hertlein, 1963: 243

Keen & Coan, 1975: 50

The species has been collected at the Galápagos and Cocos Islands, from the surface and 1,520 m.

ENOPLOTEUTHIDAE

Abrialopsis affinis (Pfeffer, 1912)

Abrialopsis hoylei, non Pfeffer 1884:

Robson, 1948: 118

Hertlein, 1963: 243

Voss (1971: 9) established the synonymy between *Abrialopsis affinis* and *A. hoylei*, auct., non Pfeffer, indicating that *A. affinis* is endemic to the American tropical Pacific, occurring from Baja California to Ecuador from the sea surface to 3,182 m. The true *A. hoylei* is an Indian Ocean species.

Pterygoteuthis giardi Fisher, 1896

Pyroteuthis giardi: Robson, 1948: 118

Hertlein, 1963: 243

This species is cosmopolitan in warm-temperate seas: Indian, Atlantic and Pacific oceans. In the eastern Pacific it occurs from southern California to the Gulf of Panama, and from the Galápagos and Cocos Islands. It has been collected from the surface to 2,500 m.

OCTOPOTEUTHIDAE

Octopoteuthis nielsenii Robson, 1948

Robson, 1948: 120

Hertlein, 1963: 243

Keen & Coan, 1975: 51

Its distribution is from the Gulf of Panama to Cocos Island; it may also occur along the Mexican coast; depth distribution has not been published.

OMMASTREPHIDAE

Symplectoteuthis oualaniensis (Lesson, 1830)

Dall, 1909: 195

Berry, 1912: 304

Robson, 1948: 127

Hertlein, 1963: 243

This species is Indo-Pacific; in the eastern Pacific it occurs from southern California to the Gulf of Panama, and the Galápagos and Cocos Islands.

OCTOPODIDAE

Octopus pusillus Gould, 1852

Hertlein, 1963: 243

Robson, 1929: 150

Keen & Coan, 1975: 52

Polypus pusillus: Dall, 1908: 194

This species was originally described from China. In the American Pacific, this species has been reported from Acapulco, Panama and Isla del Coco, in 901 to 1,789 m.

VAMPYROTEUTHIDAE

Melanoteuthis beebei Robson, 1929

Robson, 1932: 103

Hertlein, 1963: 243

Keen & Coan, 1975: 53

The species has been collected around the Galápagos and Cocos Islands from the surface to 1,372 m.

ARGONAUTIDAE

Argonauta cornutus Conrad, 1854

Robson, 1948: 197

Argonauta expansus Dall, 1872: Hertlein, 1963: 243

It is distributed from the Gulf of Panama to Ecuador and Peru.

SPECIES WHOSE PRESENCE AT COCOS ISLAND IS DOUBTFULL

In this section are listed five species whose presence at Cocos Island has been cited only once and not been confirmed by modern records. These species are absent from the geographic treatments of Keen (1971) and Keen & Coan (1975).

TROCHIDAE

Tegula gallina multifilosa Stearns, 1893

Pilsbry & Vanatta (1902: 559) cite one record of this species from Cocos Island (as *Chlorostoma gallinum multifilosum*). Biolley (1907: 26) merely repeats their record; however, Hertlein (1963: 241) calls this report into question. According to Abbott (1974: 50), this sub-species belongs to Isla Guadalupe (located 150 miles off the coast of Baja California, Mexico). The species *Tegula gallina* Forbes, 1850, belongs to the Californian province.

CYPRAEIDAE

Cypraea (Arabica) depressa Gray, 1824

The presence of this species on Cocos Island is based on the report by Demond (1957: 301): "*C. depressa* also ranges far into the eastern Pacific, occurring at Clipper-ton Island and at Cocos and the Galápagos Island (Ingram, 1951)." However, the citation of Ingram is incorrect. Ingram (1951: 25) actually states, "It was first recorded as a Western Hemisphere species from Clipper-ton Island . . . record for the west coast is the only available one at this writing." Since Demond's (1957) misquote, no other author has cited this species as occurring at Cocos Island.

COLUMBELLIDAE

Nitidella sertularium Orbigny

The only record of this species from Isla del Coco is that given by Tomlin (1928: 162), in which he indicates doubt regarding its identification. Hertlein (1963: 240) confirms that this report is probably incorrect. This species belongs to the Patagonian province (southern coasts of Argentina).

CRANCHIIDAE

Liocranchia reinhardtii (Steenstrup, 1856)

This species was cited as present in the waters of Cocos Island by Robson (1948: 128); however the species has not been collected again in the eastern Pacific. According to Rios (1975: 270), this species belongs to the Caribbean province, where there are ample records from Cuba, Puerto Rico, and Brazil.

OCTOPODIDAE

Benthoctopus januari Hoyle, 1885

The only record of this species for Isla del Coco was given by Dall (1909: 194), under the name of *Polypus januarii*. Robson (1932: 235, 240) doubts the presence of this species in the eastern Pacific. According to Rios (1975: 271), the type locality of this species is northeast Brazil, and it occurs from South Africa, the Gulf of Mexico, and Brazil.

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- [Editor's Note: Thanks to Robert Koch (Phoenix, Arizona) for help with this translation.]
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WSM SUPPORT OF STUDENT RESEARCH

The Western Society of Malacologists states in its by-laws that the purpose of the society is "to promote the study of Malacology and Invertebrate Zoology through the encouragement of research . . .". One of the ways the society has implemented this goal is by financial support of student researchers. At the first annual meeting of the society in 1968, prizes for the best student papers were presented to Marilyn Vassallo and Steven Webster. Both of these recipients went on to prove that our society's choices were excellent: Dr. Vassallo now teaches at Hartnell in Salinas and Dr. Webster is on the staff at the Monterey Bay Aquarium in Pacific Grove.

In 1972 the decision was made to offer a research grant of \$250 and to discontinue the student paper awards. It soon became obvious that the grant would be more effective if a larger sum were offered every other year, starting in 1975. In 1983, donations increased the grant to \$600.

Who may apply for this grant? It is open to all students registered part- or full-time at a college, university, or marine or field station.

What are the conditions of the grant? It is intended to initiate or further research concerned with some aspect of molluscan biology, ecology, systematics, paleontology or related fields. The recipient is expected to present the results of the research to the society at its next annual meeting.

How does one apply? The deadline for application is in April or May of odd-numbered years. The com-

pleted application form includes a research statement, a brief outline of academic background, and a letter from a faculty member or other professional scientist supervising or knowing of the student's work. The research statement, limited to 500 words, should state the nature and purpose of the project, the methods to be used, the anticipated completion date, where the work is to be conducted, how the grant funds will be used, and what other financial support is available for the project. Five copies of these materials should be submitted, one for each member of the awards committee.

How is the grant administered? Announcements of the awards are sent to relevant journals and to a mailing list of nearly 300 individuals and institutions in the western United States. Copies of the completed applications are distributed to members of the grant committee for their careful consideration. About a month after the application deadline, the committee meets for a day of deliberations, vigorously discussing the merits and limitations of each proposal and eventually reaching a decision. In recent years 16 to 27 proposals have been submitted and choosing just one recipient has been difficult. Current members of the committee are: Dr. Eugene Coan, Dr. Vida Kenk, Dr. James Nybakken, Dr. Barry Roth, and Dr. Judy Terry Smith. Former members include Dr. Peter Rodda, Dr. Carole Hickman, and Dr. James T. Carlton, the imaginative, energetic and hard-working first chairperson of the committee.

Recipients of WSM Student Research Grants

1972	Carl A. Stiefbold Biology Department Portland State University	\$250	The role of neurosecretion in the transformation of the rock-boring clam, <i>Penitella penita</i> , from the working-asexual to the resting-sexual form.
1973	Carol N. Hopper Department of Zoology University of Hawaii	\$250	The effects of particle size and concentration on the feeding behavior of the vermetid <i>Petalioconchus keenae</i> Hadfield and Kay, 1972.
1975	Judith M. Christensen Department of General Biology University of Arizona	\$500	Electrophoresis studies of selected species of the genus <i>Rabdotus</i> .
1977	Janice E. Thompson Scripps Institution of Oceanography	\$500	On the nature of the food of <i>Diodora aspera</i> (Gastropoda) and its commensal <i>Arctonoe vittata</i> (Polychaeta).
1979	Esther M. Leise Department of Zoology University of Washington Douglas J. Eernisse Center for Coastal Marine Studies U. C. Santa Cruz	\$500 \$500	The polyplacophoran girdle: its structure and function. A comparison of reproductive and electrophoretic patterns within the chiton genus <i>Cyanoplax</i>
1983	David J. Myers Dept. Biological Sciences Ca. State Univ. Fullerton	\$600	Trophic role of <i>Astraea undosa</i> .

In 1981 and 1983, the Southwestern Malacological Society asked the WSM grant committee to select a recipient for their grant of \$500. Since there are usually several proposals worth funding, this generous offer was eagerly accepted.

Recipients of SWMS Student Research Grants

1981	Elizabeth An Nesbitt Dept. of Paleontology UC Berkeley	\$500	Paleoecology of the megainvertebrate fauna from the Cowlitz Formation, Washington and Oregon.
1983	Alan C. Hebert Moss Landing Marine Laboratories	\$500	Seasonal changes in two Monterey Bay populations of scaphopods.

Several other societies also support student research. The American Malacological Union has established the Bequaert fund to promote studies on land and fresh-water mollusks. At the recent meeting in Seattle, a representative of the Hawaiian Malacological Society described their grant programs. The Pacific Northwest Shell Club has also supported students. I would very much appreciate learning about other grants that may be available, so that we can refer worthy students whom we can't fund to these other possible sources.

Members of WSM can be proud of their record of student support. The student research grant committee would welcome suggestions and donations toward increasing the award or giving more awards. The next award is scheduled to be given in 1985. Information and application forms will be available in Fall 1984 by writing to the address listed below.

Dr. Vida C. Kenk
WSM Committee on Student Grants
Dept. Biological Sciences
San Jose State University
San Jose, CA 95192

PROJECT DATA LOG: A CONTRIBUTORY DATA BASE FOR WEST AMERICAN MALACOLOGY

The Western Society of Malacologists is about to embark on an experiment that will add a new dimension to the Society in particular, and to the entire field of molluscan research in general. This experiment, for want of a better name, will be referred to as **Project Data Log**. The purpose of this project will be to act as a clearing house for the input and compilation of information on selected topics in malacology. Topics may be as varied as malacology is itself, and will consist of a clearly defined area of malacological interest that is suitable for development of a contributory data base. The Society will act as the depository of collected data with the intent of publishing such compilations in its Annual Report or as individual Occasional Papers. The purpose of Project Data Log is to elicit and publish types of malacological data that are unlikely ever to be published by themselves in any other form, but which together will provide a significant resource for malacological research.

Suitable topics for compilation in Project Data Log are endless, and could, for example, consist of geographic range extensions, new ecological and bathymetric records, bibliographic compilations. A single topic will be selected every year, to be chosen by the incoming President or by Society members at its Annual Meeting. A committee of several malacologists appointed by the President will take responsibility for gathering, reviewing and confirming data records, compiling preliminary lists for Society and/(or) external review, and final editing and preparation of copy for publication.

Following informal discussions with several Society members, the first Data Log project was chosen to be a compilation of spawning records of West American gastropods. Many of us, while in the field or on collecting trips, have observed gastropods associated with egg masses, or actually in the process of depositing egg capsules. Because of the rarity of these observations we usually make special note of them and often photograph the scene as well. However, most of these records remain unpublished and unavailable as a source of malacological data. Project Data Log will attempt to fill this gap in our knowledge of gastropod spawning records. Special data sheets for the submission of desired information are being prepared and soon will be available.

Project Data Log **MUST** be a Society effort — it cannot succeed without the willing contribution of data from Society members, or of interested malacologists in general. One of the greatest assets of the Western Society of Malacologists is its diverse membership. Many members have the good fortune to be paid for their malacological work, but often do not have the time or resources to collect or do field work when and where they may like. Many other members who may not have this good fortune are still particularly interested in collecting and often have the opportunity to observe living mollusks in their natural setting and to record, by notebook or camera, a vast amount of ecological data often not available to the library researcher. Every malacologist and/or conchologist should recognize the importance of this diversity in interest and to interact fully with those whose interests differ from their own. Only with the spirit of mutual cooperation will the Western Society of Malacologists continue to grow and prosper in the future.

George L. Kennedy, President
Western Society of Malacologists

BY-LAWS OF THE WESTERN SOCIETY OF MALACOLOGISTS

Article I Name, Purpose, Emblem

Section 1. The name of this organization shall be the Western Society of Malacologists, hereinafter referred to as the Society. (a) No provision in these By-laws shall be interpreted as superseding or abridging any provisions in the Articles of Incorporation of the Society.

Section 2. The general purpose and powers of this Society shall be to be organized and operated exclusively for educational and scientific purposes and more particularly to promote the study of Malacology and Invertebrate Zoology through the encouragement of research and the dissemination of educational material, by both lectures and publications, to persons interested in said science, and to further the interests of members and non-members alike in the study of mollusks and invertebrate organisms in general by promoting acquaintance and cooperation among them, and by encouraging publication of scientific papers.

Section 3. The emblem of the Society shall be a representation of the shell of *Astraea undosa* (Wood, 1828).

Article II Membership

Section 1. **Classes of Membership.** There shall be the following classes of membership: Charter Members; Regular Members; Student Members; and Honorary Members.

(a) Any person may become a Charter Member by the Payment of \$5.00 until 23 September 1968, at which time the Charter Membership shall be closed.

(b) A Regular Member in good standing shall be any person whose dues are currently paid in full, and who pledges agreement to abide by the Articles and By-laws of the Society.

(c) A Student Member shall be any person enrolled in a University, College, or other recognized school of learning, whose dues are currently paid in full and who pledges agreement to abide by the Articles and By-laws of the Society. Student Members shall not be eligible to hold any elective office in the Society, but may vote at regular and special meetings of the membership.

(d) Honorary Membership may be conferred upon a person because of his achievement of great merit or outstanding contribution to malacology in general, or to the Society in particular. The number of Honorary Members in the Society shall be limited to five per cent of the general membership in good standing at the time of election to Honorary Membership.

Honorary Members may be proposed by any member of the Executive Board, or in writing by not less than 5 members in good standing, with documentation. The President shall appoint a committee of 3 disinterested persons to investigate the merit of the nomination. Upon the favorable report of said committee a secret ballot shall be had among the Board; a 2/3 majority shall be

required for affirmative action. If the ballot is favorable, the President shall appoint a committee to prepare the ceremonial presentation of the Honorary Membership. Honorary Members shall not be liable for dues, and shall not be entitled to vote on affairs of the Society.

(e) Membership is not transferable, and ceases upon death of the member.

(f) A member may be deprived of membership in the Society for acts or behavior detrimental to the Society or its objectives. The Executive Board shall investigate charges brought to its attention; if said detrimental acts are confirmed, the accused shall be automatically dismissed from the Society.

Article III Dues

Section 1. **Dues.** Annual membership dues will be set by the Executive Board and confirmed by a majority vote of members present at the annual business meeting.

(a) Dues for the ensuing calendar year are payable annually during the month of January; if dues are not paid by 1 April the member shall be delinquent and shall lose all rights and privileges and will be considered a member **not** in good standing; his name shall be stricken from the membership rolls.

(b) Dues for Student Members shall be 40% of the dues for regular membership.

Section 2. **Assessments.** No assessments of any kind shall be levied for any reason at any time, aside from the annual dues.

Section 3. **Annual Meeting Costs.** In the handling of the annual meetings of the Society, the intention shall be to cover all legitimate expenses by any or all of the following means: a registration fee to be paid by all who attend the annual meeting either full or part time, except Honorary Members and officially invited guests, in an amount established by the President after consultation with the Treasurer and the Auditing Committee; by dues; or by monies available to the Society by other legal means.

Article IV Officers

Section 1. **Officers.** The elected officers of the Society shall be a President; a First Vice-President; a Second Vice-President; a Secretary and a Treasurer.

(a) The terms for these offices shall normally be for one year, beginning one month after election which shall be held at the annual meeting of the general membership. No elected officer shall succeed himself, except that the offices of Treasurer and Secretary may be held by the incumbents for a period not to exceed five (5) years.

(b) Appointed officers and committees serve at the pleasure of the President; it is within his power to remove any such officers and committee members for any reason whatsoever.

(c) If an elected officer fails to fulfill the duties of his office or if he performs his duty in a manner that will reflect unfavorably upon the Society or its objectives he

may be recalled. A special election shall be called by the President of the Society at the next meeting of the general membership, such special election to be announced, together with the reasons thereof, to the regular members in writing at least two weeks in advance of the meeting. A secret ballot shall be held and a two-thirds majority vote may remove the accused officer from his office. The Nominating committee shall put in nomination another member's name to be approved by unanimous vote of the Executive Board remaining, to serve out the rest of the term. A person thus removed from office shall not have his name put in nomination for any office.

Section 2. Duties of Officers. The officers shall perform the usual duties of their offices.

(a) The **President** shall preside at annual meetings and be generally responsible for the activities of the Society. He shall appoint a Nominating Committee and such other committees as he deems desirable. At the end of his term of office he shall appoint an Auditing Committee, and may appoint a Mentor-Parliamentarian to serve during the term of his successor. The President shall be guided, additionally, by the policies contained in the Officer's Manual.

(b) The **First Vice-President** shall act for the President if the latter is unable to serve after all preliminary organizing of the annual meeting has been completed.

(c) The **Second Vice-President** shall assume all responsibility for organizing an annual meeting of the Society if the President-elect, for any reason, should become unable to assume the duties of his office at any time before the meeting has been organized. He shall thereby succeed to the office and title of President of the Society.

(d) The **Secretary** shall take all minutes of the Executive Board and Business meetings, transcribe them as promptly as possible and transmit copies of the President (for review) and to the Mentor-Parliamentarian, if one has been appointed (for his permanent record). The Secretary shall also take such notes during annual meetings as may be appropriate, and handle all necessary correspondence, as directed by the President or otherwise required, keep the other members of the Executive Board informed on matters that concern them, and maintain the records of the Society. The Secretary shall be guided, additionally, by the policies contained in the Officers' Manual.

(e) An **Assistant Secretary** may be appointed by the Secretary to assist in the regular duties of the office and the promotion of the annual meeting, but will not be considered a member of the Executive Board, and need not be a member of the Society.

(f) The **Treasurer** shall be responsible for handling and recording all incoming and outgoing funds of the Society, subject to the approval of the Auditing Committee of any unprecedented or unusual expenditure. He shall maintain an up-to-date list of all members of the Society in good standing.

(g) At the annual meeting of the Executive Board and at the annual membership meeting the Treasurer shall submit a financial report on the general Society fund. Within thirty (30) days after the annual meeting

the Treasurer shall prepare a financial report, in triplicate, of the general Society fund and all other funds handled during the annual meeting, and shall submit this report to the Auditing Committee for approval, and to the outgoing President for signature and transmittal of one copy of the newly elected President; one copy shall be filed in the Treasurer's Handbook, and one copy shall be transmitted to the Mentor-Parliamentarian for his permanent file. This shall constitute a final financial report, including all monetary transactions of the Society during his term of office. The Treasurer shall be guided, additionally, by the policies and procedures contained in the Officers' Manual.

(h) An **Assistant Treasurer** may be appointed by the Treasurer to assist in the regular duties of the office and in handling the affairs of the annual meeting, but will not be considered a member of the Executive Board, and need not be a member of the Society.

(i) The **Mentor-Parliamentarian** may be appointed by the outgoing President; he will be an ex officio member of the Executive Board, without vote. The Mentor-Parliamentarian will serve in an advisory capacity to incoming officers and committees on questions relating to the By-laws, and to procedures and policies as reflected in the Minutes and other records of the Society. The same person may be reappointed to this position by subsequent Presidents.

Section 3. Each elected Officer shall maintain and pass on to this successor a Manual enumerating the duties of his office, policies of the Society affecting their accomplishment, and other information and procedures designed to enable complete and consistent performance of the duties of the office concerned.

Article V Executive Board

Section 1. The Executive Board. The administration of the affairs of the Society shall be vested in the Executive Board, which shall consist of the currently elected officers, two Members-at-Large to be elected from among the general membership, and the three most recent Past Presidents of the Society, although the presence of the latter three may be optional. All the preceding shall be entitled to one vote each if in attendance, or in any and all mail polls of the Board.

(a) Vacancies among the current officers shall be filled through appointment by the President, from the regular membership.

(b) No person shall be an Executive Board member who has not been a member in good standing of the Society for at least one immediately preceding year.

(c) The Executive Board shall meet annually during the Society's annual meeting, prior to the regular business meeting, and at such other times as called by the President, or as agreed upon by a majority of the Executive Board members. Insofar as possible, matters requiring action in between the Society's annual meetings shall be handled through a mail poll of the Executive Board by the President.

(d) A quorum shall consist of three members holding elective office.

(e) The Executive Board shall decide on all matters involving policy unless otherwise specifically provided for in the By-laws, but its decisions are subject to ratification by a majority vote of the Society's members in good standing at the annual meeting.

(f) The Executive Board shall set the time and place of the next subsequent annual meeting.

Article VI Committees

Section 1. **Standing Committees** shall be the Nominating Committee and the **Auditing Committee**, both of which shall be appointed by the President.

Section 2. **Nominating Committee.** At least one candidate for each office shall be nominated by a Nominating Committee of three, appointed by the President from the list of Past Presidents. The committee shall present its slate of nominations at the annual business meeting. Additional nominations may be made from the floor of the annual business meeting, and consent to serve, if elected, may be secured from the nominee at that time. Elections may be by a majority vote, but if there is more than one candidate for office, a majority vote by written ballot will determine the election.

(a) No candidates shall be nominated without prior consultation as to their willingness to serve if elected.

(b) If a written ballot is required, the President shall appoint a Tally Committee, apart from the nominees, to count ballots and certify the result.

Section 3. The **Auditing Committee** shall consist of three qualified members of the Society, appointed by the outgoing President. It shall be the primary duty of this committee to consider any unprecedented or unusual expenditures, and ascertain the legality, or advisability, or both, and authorize or refuse authorization of such payment by the Treasurer. This committee shall receive and approve all financial reports prepared by the Treasurer.

Article VII Meetings

Section 1. Meetings of the general membership may be held at the call of the President or upon written application of at least twenty (20) regular members of the Society. In any event, a minimum of one regularly scheduled meeting of the general membership shall be held each year, at a time and place selected by majority vote of the attending membership at the general meeting next preceding.

Section 2. In the case of meetings of the general membership other than the regularly scheduled annual meeting, the Secretary will, at least thirty days in advance of the date scheduled for the special meeting, advise the regular membership of the purpose, date, time and place of such meeting. Any application by the membership for a special meeting to be held must state the purpose for which it is requested.

Section 3. At the regularly scheduled annual meeting of the general membership, a quorum shall consist of ten

percent (10%) of the regular members attending the meeting, but not of less than three such members.

Section 4. At special meetings called either by the President or at the request of twenty or more of the regular members, a quorum shall consist of 10% of the then current regular membership.

Section 5. At any meeting of the regular membership called to consider dissolution and fiscal termination of the Society, a quorum shall consist of seventy-five percent (75%) of the then current regular membership plus one regular member. In lieu of this meeting, a mail ballot may be substituted, with a majority vote consisting of at least seventy-five percent (75%) of the then current regular membership being regarded as also representing a legitimate quorum.

Section 6. Meetings of the Executive Board shall be held as provided in Article V of these By-laws.

Section 7. The conduct of all meetings of the Society and of the Executive Board shall be governed by Roberts' Rules of Order, the Articles of Incorporation, these By-laws, and the law of the United States of America.

Article VIII Fiscal Policies

Section 1. The fiscal year of the Society shall begin 1 January and terminate the following 31 December, annually. Termination of the first fiscal year of the Society shall be at the close of the 31 December next following completion of incorporation and registration with the State of California.

Section 2. No expenditure may be incurred nor any financial obligation assumed on behalf of the Society by any member, committee, or office of the Society, without the express approval of the Auditing Committee.

Section 3. Should dissolution of the Society be considered, a written ballot shall be requested by the President. A three-fourths majority vote of the entire then current regular membership by written ballot shall dissolve the Society. Any funds or any other assets belonging to or accruing to the Society after all just claims against the Society shall have been satisfied, shall be transferred to a selected fund, foundation or corporation organized solely for educational and scientific purposes as now defined under Section 501 (c) (3) of the Internal Revenue Code of 1954, such selection to be made by the then voting regular members.

Section 4. Prior to requesting a vote on dissolution of the Society, the President shall appoint a Committee of five regular members of the Society to select a proposed listing of no less than three and no more than five funds, foundations, or corporations as defined in the next preceding paragraph, and these shall be listed on the ballot distributed for vote on dissolution. Each regular member shall be entitled to vote for one of the listed organizations, and a simple plurality shall prevail.

Section 5. All persons or corporations extending credit to, contracting with or having any claim against the corporation or the Executive Board shall look only to the funds and property of the corporation for payment of any such contract or claim or for the payment of any debt, damage, judgment or decree, or any other money that may otherwise become due or payable to them from the corporation or the Executive Board, so that neither the members of the Society, the Executive Board, or Officers, present or future, shall be personally liable therefor. Under no circumstances shall the Society, its property, officers or members be responsible for any debts, damages or liabilities of any kind or nature, incurred or sustained, unless proper prior approval has been established as provided in these By-laws.

Article IX Amendments of By-laws

Section 1. **Amendments.** Proposals for amendments or deletions of or additions to the By-laws of the Society may be made by the Executive Board or by ten percent of the general membership in good standing. Upon receipt of a proposed amendment or addition, the President shall appoint a special committee to study such proposals and to ascertain that such proposals are not in conflict with the interests and objectives of the Society and that they are not in violation of the provisions of the Non-Profit Corporation Act of the State of California; this special committee shall also draft the amendment or addition for presentation to the general membership. The membership shall be notified in writing of the intended amendment or addition, at least fifteen days before meeting, the fifteen days to be counted beginning 24 hours after the notice shall have been deposited in the United States Mail. A two-thirds majority vote of the regular members in good standing present shall be necessary to adopt such amendment, provided that there is a quorum as specified in Article V (d) in these By-laws.

Section 2. No provision in the By-laws shall be interpreted as superseding or abridging any provisions in the Articles of Incorporation of the Society.

Article X Award of Honor

Section 1. **Award of Honor.** An Honor Award is hereby established, to be conferred in recognition of outstanding accomplishments or contributions in the fields of Conchology and Malacology.

(a) Membership in the Society shall not be a requirement for the Honor Award.

(b) No more than one such award shall be conferred in any one year, nor shall one necessarily be conferred each year.

(c) Nominations for an award, accompanied by suitable documentation, shall be submitted in writing to the Executive Board, signed by not less than five Society members in good standing, at least one month before the scheduled Society meeting at which the award is to be conferred; nominations may also be presented by any member of the Executive Board. The Executive Board shall ballot by mail on the nomination, and a simple majority affirmative vote of the Board shall be sufficient for adoption of the nomination.

(d) The Award shall consist of a diploma of merit, and shall be signed by the President and the Secretary.

(e) The President shall appoint a committee to take the necessary steps to prepare the Diploma for presentation.

Article XI Publications

Section 1. **Editor.** An editor is to be appointed by the President, subject to approval by the Executive Board. The editor shall, in turn, appoint an Editorial Board, including such assistants as he deems necessary to carry out his duties and to review the content of full-length papers as specified in Section 3.

Section 2. **Publications.**

(a) The editor shall arrange to have published an **Annual Report** based on the proceedings of the Society's annual meeting, including a summary of the actions taken at the Society's Annual Business and Executive Board meetings, a report from the Treasurer, and such abstracts and full-length papers as the Editorial Board deems appropriate.

(b) The editor may arrange to have published such other material as serve the purposes of the Society, subject to approval by the Executive Board.

Section 3. **Technical Review.** When full-length papers are included in the **Annual Report** or other of the Society's publications, they are to be reviewed by two technically qualified members of the Editorial Board in addition to the editor.

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THE WESTERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT



**SANTA CRUZ, CALIFORNIA
16-19 August, 1984**

Volume 17

The Western Society of Malacologists

ANNUAL REPORT

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Issued: August 28, 1985

WESTERN SOCIETY OF MALACOLOGISTS
17th Annual Meeting, Crown College, University of California
Santa Cruz, California
16-19 August 1984

August 16

Morning. Registration.
Afternoon. Contributed Papers, F.G. Hochberg, Chairperson.
Informal Get Acquainted Part, Rose Marie Kennedy, Hostess.
Evening. WSM Executive Board Meeting.
Slide Shows, Paul H. Scott, Coordinator.

August 17

Morning. Symposium on the mollusk fauna of northwestern Baja California, Hans Bertsch, Chairperson
Contributed Papers: Hans Bertsch, Chairperson
Afternoon. Opisthobranch Symposium: Terrence M. Gosliner, Chairperson
Discussion group on use of computers in malacology.
Evening. Shell and book auction, Carole M. Hertz and William D. Pitt, Co-auctioneers.

August 18

Morning. Contributed Papers: Barry Roth, Chairperson
Afternoon. Paleontology Symposium: George L. Kennedy, Chairperson
Evening. Banquet, Steven K. Webster, Speaker: "The Monterey Bay Aquarium: A window into Monterey Bay.

August 19

Morning. Open House at Long Marine Laboratory, Gary McDonald, Coordinator.
Open House at Moss Landing Marine Laboratory, James W. Nybakken, Coordinator.
Field Trip to Elkhorn Slough Estuarine Sanctuary, Mark A. Silberstein, Trip Leader.

1984 AWARD WINNERS, BEST STUDENT PAPER COMPETITION

First Award: Kathleen M. Langan, University of California, Santa Cruz, for her paper on "Comparative studies in two co-occurring species of chink snail *Lacuna*"
Second Award: Daniel J. Ponti, University of Colorado, Boulder, for his paper on "Amino acid composition of Pleistocene bivalves: Preliminary results from the San Pedro area, California"
Third Award: David J. Myers, California State University, Fullerton, for his paper on "The trophic role of *Astrea undosa* (Wood)"

Abstracts and Titles of Papers Presented to the Annual Meeting

THE POPULATIONS OF *MYTILUS CALIFORNIANUS* ALONG THE NORTHWESTERN BAJA CALIFORNIA PENINSULA

Luis E. Aguilar Rosas,¹ Hans Bertsch,² and Isai Pacheco Ruis,¹

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A survey of the entire Pacific coast of the state of Baja California, Mexico, revealed major harvestable banks of *Mytilus californianus* Conrad at Bajamar and Eréndira. Populations of mussels in the central and southern portions of the state are restricted to limited occurrences on projecting rocky promontories

Density, biomass and size-class distributions were determined for the two large mussel banks at Bajamar and Eréndira. Bajamar has a larger total biomass of all mussels and a larger area of coverage, but a smaller density of mussels. Eréndira has just the opposite pattern. By contrast, seedlings (1 to 2.9 cm in size) have both a greater density and total abundance at Eréndira than at Bajamar (despite the area difference).

STALKING THE WILY GOOEYDUCK

Roland Anderson
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[Slide presentation, abstract not submitted]

THE OPISTHOBRANCH FAUNA OF THE CALIFORNIA CHANNEL ISLANDS

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The opisthobranch fauna of the California Channel Islands has received very little attention in the scientific literature. With the establishment of the Channel Islands National Park and Marine Sanctuary, and increased oil exploration in the Santa Barbara Channel, interest in the indigenous flora and fauna of the island group has increased. We conducted an inventory of opisthobranch mollusks known to reside in the islands and a statistical analysis of the faunal affinities of the islands to one another and to the hydrographic conditions around each island.

A total of 90 species of opisthobranch mollusks was tallied for the island group. Three undescribed species are endemic and not found on the mainland. A scoring of species as northern or southern indicates that the islands support a primarily northern fauna; 63 species range mainly to the north. Analysis of faunal affinities using principal component analysis indicates that the islands can be viewed in 3 subunits. These subunits agree favorably with hydrographic conditions of the area.

SYMPOSIUM — THE MOLLUSK FAUNA OF NORTHWESTERN BAJA CALIFORNIA: INTRODUCTORY REMARKS

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The outer coast of the Baja California peninsula is a zoogeographic region of great interest. It stands midway between the tropical Panamic province and the cooler temperate California province. Because of its geographic location, the area is a natural laboratory in which to study the comparative abundance and distribution of marine organisms.

The political boundary between Mexico and the United States has caused a serious bias in our knowledge, masking the dynamics of biological interactions along this coastline. Numerous marine organisms are thought to have their southern distributional limit at San Diego. This is an artifact of lack of collecting south of the border. During 2 years of research in Ensenada and the surrounding Bahia Todos Santos, most of the marine invertebrates and algae found were well known southern California species. I would predict that almost every marine species found at Santa Barbara or San Diego will also be found in Ensenada. In this sense, the northwest coast of Baja California is not unique, but is simply the southern portion of the cooler temperate Californian faunal province.

The species composition along the entire outer coast of Baja California, however, gradually changes from north to south, so that the end result is a totally different faunal assemblage at either end of this range. Because the faunal gradient changes from temperate to tropical, any precise lines drawn between faunal provinces, or at international boundaries, will be misleading. Provincial boundaries are very useful, but we must remember that the distribution of animals will cross these lines, although with less frequency at either extreme of the peninsula.

Zones of study should be biologically meaningful. One should study a particular area to determine biological interactions and zoogeographic distributions of organisms. This symposium examines the varying distributions of mollusks along northwestern Baja California, from the U.S.-Mexico border to the southern boundary at Estero de Coyote on the Punta Eugenia peninsula.

A BIOECONOMIC SCENARIO FOR THE EVOLUTION OF NUDIBRANCH GASTROPODS

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The adaptive radiation of opisthobranch gastropods reflects the kind of food eaten and is constrained by defensive materials derived from food. The anatomy of *Bathydoris* implies that, although dorids are distinct from cladohepatic nudibranchs, the nudibranchs are a monophyletic group. It further suggests that the ancestral food of nudibranchs was toxic cnidarians. If so, the

feeding of dorids on sponges may have evolved late in their adaptive radiation. A separate radiation of the cladohepatic nudibranchs was facilitated by the preadaptive role of ingestion of defensive chemicals.

THE BERNARDINIDAE OF THE EASTERN PACIFIC (BIVALVIA)

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The Bernardinidae is a family of minute, shallow-water marine bivalves that are known only from the eastern Pacific. The species are characterized by an internal ligament with 3 cardinal teeth in the left valve, 1 or 3 in the right, and at least 1 lateral tooth. The 4 known species brood their young. I place the family in the Cyamiacea instead of in the Arcticea where it has previously been placed.

In *Bernardina*, the anterior end is longer than the posterior; there is heavy concentric sculpture; and there is a large anterior lateral tooth, and no posterior lateral tooth. *Bernardinabakeri* Dall, the type species, occurs from Pacific Grove, California, to Isla Natividad, Baja California Sur. *Bernardina margarita* (Carpenter) occurs from Isla Guadalupe, Baja California, to Bahia Banderas, Jalisco, Mexico.

In *Halodakra*, the posterior end is longer than the anterior; the sculpture consists of fine concentric threads; and there is a posterior lateral tooth. *Halodakra* s.s. lacks an anterior lateral tooth. *Halodakra* (*H.*) *subtrigona* (Carpenter), the type species, occurs from Tomales Bay, California, to Mancora, Peru. A new subgenus [*Stohleria* Coan, 1984] is erected for *H. salmonea* (Carpenter), which has an anterior lateral tooth. This species occurs from Brookings, Oregon, to Punta San Hipolito, Baja California Sur. *Crassatella marginata* Keep and *Psephidia brunnea* Dall are synonyms of *H. salmonea*.

[The complete text of this paper is published in *The Veliger*, 27(2):227-237 (1984).]

ADAPTIVE RADIATION AND CONVERGENCE IN THE UNIONIDAE (BIVALVIA) OF THE CAPE FEAR RIVER BASIN, NORTH CAROLINA

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The Cape Fear River basin has an abundant and diverse fauna of unionid bivalves. Six nominal species described by Isaac Lea were collected from their type localities and re-evaluated, including a comparison of their soft anatomies. *Elliptio nasutula* (Lea, 1863), a member of the *E. lanceolata* complex, is recognized as a valid taxon. "*Unio*" *squalidus* Lea, 1863, is verified anatomically as a synonym of *Unio merus obesus* (Lea, 1831). "*Unio*" *chathamensis* (Lea 1863), which has a purple nacre, is a synonym of *E. complanata* forma *micans* (Lea, 1857), which has an orange nacre, based on extensive hybridization of nacre color in the two forms. *Elliptio complanata* forma *micans* and *E. icterina* forma *spadicea* (Lea, 1857) of the Rocky River have diverged considerably in shell phenotype from *E. complanata* forma *livingstonensis* (Lea, 1863) and *E. icterina* forma *lucida* (Lea, 1863) of Livingston Creek and (or) the lower Cape Fear River, whereas soft anatomies remain relatively conservative at the species level.

The fall line may be an effective barrier to gene flow among the congeneric populations of unionids in the Cape Fear River basin. Phenotypic divergence among the unionid populations was further confirmed by distinct shell phenotypes above and below the fall line in *E. marsupiobesa*

Fuller, 1972, *Anodonta cataracta* (Say, 1817), *Villosa constricta* (Conrad, 1838), and *V. delumbis* (Conrad, 1834). Environmental selection for shell phenotype has resulted in indistinguishable shell homeomorphs in sympatric populations of *E. complanata* and *E. marsupiobesa* above and below the fall line.

THREE GASTROPOD FAMILIES THAT TRUNCATE THEIR SHELLS IN SOME SPECIES, AND HOW THEY BUILD PLUGS

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The gastropod families Caecidae, Truncatellidae, and Buccinidae each include species that discard unwanted portions of their shells by constructing internal plugs that allow truncation of the initial whorls. Study of this phenomenon is facilitated by examining sectioned shells that reveal cross sections of the plug, or septum, as it is called. All species of Caecidae, except those in the genus *Streblocerus*, practice truncation of earlier portions of their shells, usually several times, by weakening the shell from inside, then building from the inside a new plug at that position. Shells are often found that have not yet shed the unwanted portion following construction of another plug. Sectioned shells have shown as many as three plugs in one shell.

Truncatellid species practice truncation when the shell reaches about seven whorls. The shell is cut off at about the fifth whorl, then a plug is built over the open portion of the new apex, probably from the outside first, then finished from the inside. The animal then adds two more whorls before reaching maturity.

In the buccinids, only species of the subgenus *Caducifer* s.s. practice truncation. This is done once, as in the Truncatellidae, but the shell is only weakened, letting wave action truncate it. The plug is constructed from the inside and finished with a colored coating like that on rest of the shell, after truncation has occurred.

NOMENCLATURAL REVIEW OF THE GENUS *BERTHELLINA* IN THE NORTHEAST PACIFIC

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[Abstract not submitted]

THE SIGNIFICANCE OF GILL PLACEMENT IN CHITONS

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A preliminary survey of the position of gills in a wide variety of chiton species has revealed certain patterns with both phylogenetic and functional implications. Members of the family Lepidopleuridae Pilsbry, 1892 are especially noteworthy in their gill placement, which is unique among Recent chitons. Of the 17 species from this family included in the survey, all possessed gills that are located only in the posterior cavity, which surrounds the anus.

By contrast, all 81 species surveyed from other families possessed gills that extended to the

anterior portions of each pallial groove. Moreover, each gill row typically ended some distance from the anus, in a position that functionally divided the pallial groove into inhalant and exhalant chambers as first described by Yonge [1939, *Quart. Journ. Microsc. Sci.*, 81(3): 367-390]. A similar functional block is impossible with the gill placement possessed by lepidopleurids.

Other factors typifying each chiton species also affect gill morphology to some extent. These include adult body size, bathymetric range, and reproductive behavior, such as brooding. None of these factors, however, appears to account for the sharp distinction between lepidopleurids and all other Recent chiton species. Because lepidopleurids have long been regarded as the most primitive of Recent chitons on the basis of shell plate morphology and fossil evidence, it is conceivable that gill morphology could be used to unite all "modern" chiton species. In other words, all "modern" species may have descended from an ancestor with an anterior gill placement.

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PREDATION BY *TRITONIA FESTIVA* ON AN UNDESCRIBED ALCYONACEAN SOFT CORAL FROM CAPE ARAGO, OREGON

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The nudibranch *Tritonia festiva* (Stearns) is the major predator of an undescribed alcyonacean soft coral that occurs at Cape Arago, Oregon. The soft coral forms low, rounded, salmon-colored colonies up to 15 mm in diameter and occurs in large aggregations of evenly spaced colonies under low-intertidal ledges. These aggregations are formed, at least in part, by colony fission. Y-maze and current-flow experiments indicate that *T. festiva* generally crawls in a cross-current to up-current direction and utilizes distance chemoreception to locate the soft coral. Upon contacting an expanded coral with its sensitive frontal veil or rhinophores, *T. festiva* pulls back its head, slows its crawling, raises the frontal veil and everts its labial tube. Using the tactile senses of the labial tube and frontal veil, the labial tube is positioned over 1 or a few polyps. This contact does not cause polyp contraction. Once positioned, *T. festiva* rapidly thrusts its head forward while protracting its buccal mass. The jaws and radula make a number of strikes in rapid succession, and 1 to 7 polyps are ripped out of the colony as the rest of the polyps rapidly contract. Little, if any, coenenchyme is ingested. *Tritonia festiva* will not attack contracted colonies and apparently cannot consume entire colonies (small colonies may be an exception). In addition to the rapid contraction of polyps into the tough, spiculate coenenchyme, the corals possess another defense against predation by *T. festiva*, an intercolony alarm response. Downstream colonies can sense that an upstream colony is being attacked and will respond with rapid contraction of their polyps. A series of experiments indicates that the substance(s) eliciting this response originates from the attacked colony and not from *T. festiva*. The attacked corals may be releasing an alarm pheromone.

FOOD HABITS OF SOME NUDIBRANCHS FROM CAPE ARAGO, OREGON

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Food records (prey species) for 20 species of rocky intertidal nudibranchs from Cape Arago, Oregon, have been determined by observing the close association of nudibranchs and their suspected prey in the field, and by laboratory observation of feeding. The following 10 food records are new: *Adalaria* sp. on *Hincksina minuscula* (Hincks), *Archidoris montereyensis* (Cooper) on *Hymeniacion ungodon* de Laubenfels, *Cadlina luteomarginata* MacFarland on *Aplysilla glacialis* (Dybowski). *Cadlina modesta* MacFarland on *Halisarca* sp., *Crimora coneja* Marcus on *Hincksina minuscula*,

Cuthona cocoachroma Williams & Gosliner on *Thuiaria* sp., *Cuthona fulgens* (MacFarland) on *Sarsia* sp., *Discodoris heathi* MacFarland on *Mycale macginitiei* de Laubenfels, *Doto kya* Marcus on *Plumularia* sp., and *Onchidoris muricata* (Mueller) on *Eurystomella bilabiata* (Hincks) and *Microporella cribosa* (Osburn). In addition, the feeding of *Hallaxa chani* Gosliner & Williams on the sponge *Halisarca* sp. was confirmed. Many of these nudibranchs closely resemble their prey in color; *Hallaxa chani* also resembles its prey in surface texture. Some species, including *Cadlina luteomarginata*, *C. modesta*, and *Laila cockerelli* MacFarland, are not cryptic on their prey and are undoubtedly examples of aposematic coloration. By observing marked boulders over a period of time, the progress of selected examples of dorid predation on sponges was observed, indicating that some dorids are capable of consuming large quantities of prey. It was concluded that nudibranchs are ecologically important predators whose role in structuring encrusted animal communities should be pursued further.

[For further information, see *The Veliger*, 27(2):143-165 (1984).]

LECITHOTROPHIC DEVELOPMENT IN THE NUDIBRANCH *DOTO AMYRA* MARCUS

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Aspects of the larval development of the nudibranch *Doto amyra* Marcus from Cape Arago, Oregon were described. *Doto amyra* feeds on *Abietinaria* sp. and lays small egg masses on the basal portions of the hydroid. The egg masses are cream to yellow colored, laterally flattened, slightly crescent shaped, and laid on edge. There is one egg per capsule. Mean egg diameter varied from 145 um to 153 um in 6 egg masses laid in May. After a developmental period of 19 to 21 days (at 15-17°C) the larvae hatch out as crawling veligers characterized by large eyespots, a large foot with a well developed propodium, a type one shell with a mean length of 238 um, a small velum, and poor swimming ability. Hatching larvae lack a mantle fold. After about one day of crawling on *Abietinaria* sp., the larvae anchor themselves to the hydroid perisarc, presumably with pedal gland secretions, and begin metamorphosis. At two days posthatching, the larvae are in the same positions, have lost the velum, and have developed a small radula. The larvae crawl out of their shells three to 5 days after hatching, and metamorphosis into a juvenileslug is complete in one to two more days. Feeding on *Abietinaria* sp. was first observed 7 days posthatching. At this stage juveniles are nearly 300 um long. Twelve days after hatching the juveniles are about 360 um long and possess two pairs of cerata buds. At 38 days posthatching the juveniles measure approximately 750 um in length and have rhinophore buds and three pairs of cerata. *Doto amyra* is the first northeastern Pacific nudibranch known to have lecithotrophic larval development.

SOUTH AFRICAN MOLLUSKS

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[Slide presentation, abstract not submitted]

OPISTHOBRANCHS FROM THE SEYCHELLES ISLANDS

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The Seychelles represent the only granitic oceanic islands in the world and are among the most isolated in the Indian Ocean. The marine fauna of the Seychelles is relatively impoverished, perhaps due to the isolation from major oceanic currents. Although the fish fauna is well known, very few studies have been conducted on the invertebrate faunas. The opisthobranch gastropods of the Seychelles are poorly known and Eliot [1910, *Trans. Linn. Soc. Zool.*, ser. 2, 13(2):411-439] and Edmunds [1972, *Rev. Zool. Bot. Afr.*, 85(1-2):67-923] have recorded only 17 species from here. The present field work yielded specimens of 30 species of opisthobranchs, 25 of which constitute new records for the islands. Seven of these species appear to be undescribed and detailed morphological and systematic study of these taxa is in progress.

The opisthobranch mollusks present in the Seychelles have faunal affinities with those of other tropical regions of the Indian and Pacific Oceans. Three species, all members of the order Anaspeidea, are circumtropical. Three additional species are known only from the western Indian Ocean. The vast majority of taxa (16 species) are widely distributed throughout the Indian and Pacific Oceans.

OPISTHOBRANCH MOLLUSKS OF THE PUNTA EUGENIA REGION, WITH A DISCUSSION OF THEIR BIOGEOGRAPHIC AFFINITIES

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The faunistic affinities of the Pacific coast of Baja California are the subject of considerable controversy. The region is characterized by variable physical oceanographic conditions that produce a complex overlap of Californian and Panamic taxa. Fifty species of opisthobranchs were collected from 14 localities in the vicinity of Punta Eugenia, from Capitos to Estero de Coyote. Of these, 10 species constitute range extensions; 6 southern and 4 northern. Three species are presently undescribed.

Twenty-one of the species encountered are widespread in both the Californian and Panamic provinces; 13 are Californian and 11 are Panamic. Jaccard's coefficient of similarity demonstrates that the opisthobranch fauna has slightly greater affinities to the Californian region than to the Panamic region. Previously, Brusca [1980, *Common intertidal invertebrates of the Gulf of California region*] suggested that the area around Punta Eugenia represents the northernmost point with dominant Panamic affinities. Clearly, seasonal and other temporal climatic and biological factors may alter the relative proportions of Californian and Panamic taxa. This important region of overlap between provinces requires much more thorough study before the subtleties of biogeographical relationship can be fully understood.

ASPECTS OF THE REPRODUCTIVE BIOLOGY OF SEVERAL MONTEREY BAY SCAPHOPODS

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From March 1983 until June 1984, bottom samples of invertebrates were taken from near the head

of the Monterey Submarine Canyon using a weighted epibenthic sled. Over the sampling period, four species of scaphopods were taken: *Dentalium (Rhabdus) rectius* Carpenter, *Cadulus fusiiformis* Pilsbry & Sharp, *Siphonodentalium quadrifissatum* (Pilsbry & Sharp), and *Pulsellum salishoram*.

Microscopical investigations of gonadal development in relation to the month the animals were captured were done by making thin sections with a microtome and staining with Delafield's hematoxylin and eosin. Differences in sperm morphology were noted as well as the timing of reproductive activity and length of time taken for newly settled animals to grow to maturity.

SURVEY OF MOLLUSKS AT PUNTA ASUNCION AND VICINITY, BAJA CALIFORNIA SUR, MEXICO DURING NOVEMBER 10-14, 1981

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Collecting was conducted both intertidally and subtidally at Punta Asuncion and vicinity. Random bottom samplings were taken in depths to 30 m from sites off Isla Asuncion, Isla San Roque, and a sea mount approximately 5 km west of Isla Asuncion. The mollusks collected were a combination of those found in the Californian and the Panamic provinces. Totals to date include 51 species of bivalves, 136 gastropods, 7 chitons, one scaphopod, and one cephalopod. The most common intertidal species were those of the Californian province.

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PARASITES OF HOLOPELAGIC MOLLUSKS

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Representatives of three protozoan and 5 metazoan phyla have been recorded in association with holopelagic mollusks. Both pelagic gastropods and cephalopods harbor a number of unique parasitic genera. The ciliophorans, *Chromidina*, *Opalinopsis*, and *Syringopharynx*, and the sporozoan *Molluskocystis* occur exclusively in pelagic molluscan hosts. In addition, several unusual new genera of ciliophorans have been recovered from the excretory organs and gills of cephalopods. Several hydrozoan genera attach exclusively to the shells of pteropod mollusks and at least one genus, *Kinetocodium*, may be ectoparasitic.

Cephalopods commonly serve as important second intermediate or reservoir hosts for a diversity of larval digeneans, cestodes and nematodes that mature in bony fishes, sharks and marine mammals. In most cases, these larval helminths have not been identified with adult stages in appropriate vertebrate final hosts. In contrast, larval helminths only rarely have been recorded in pelagic gastropods. Adult copepods of three genera, *Pteroxena*, *Micrallecto*, and *Nannallecto*, have been described from gymnosome gastropods, and larval stages of *Cardiodectes* are frequently found on the gills of a number of ptenoglossans, heteropods and pteropods. Pelagic cephalopods rarely host copepods either as adults or larvae.

THE BIVALVE FAMILY PHOLADIDAE IN THE NORTHEASTERN AND NORTHWESTERN PACIFIC: REVIEW OF NOMENCLATURAL PROBLEMS

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Despite publication in recent years of major monographs on the family Pholadidae (Mollusca: Bivalvia) of the eastern Pacific region, a number of nomenclatural problems in the family still need to be addressed, particularly in the genus *Penitella*. Most of these problems became apparent only as the need arose to identify several enigmatic species of *Penitella* from the North Pacific. In the process, existing museum collections were re-evaluated and new and previously unstudied collections of pholadids from Alaska and Japan were examined. The nomenclatural status of one fossil and several modern species needs revision; preliminary findings are as follows:

1) An undescribed species of large pholadid from the Miocene of California and Washington (?) is similar to *Chaceia ovoidea* (Gould), but lacks a callum in the adult stage, necessitating a redefinition of *Chaceia* if the species is not to be included in *Zirfaea*. The species differs considerably from *Z. dentata* Gabb from the California Miocene.

2) *Penitella gabbii* (Tryon), long thought to be an eastern Pacific species, is actually a Japanese species and is a senior synonym of *P. kamakurensis* (Yokoyama). The eastern Pacific species is without an available synonym and will be described as new.

3) The name *Penitella kamakurensis* (Yokoyama) is used commonly in Japanese literature for at least two species. The nominal species is a junior synonym of *P. gabbii* (Tryon); the second species appears to lack a name, subject to a further review of Chinese, Japanese, and Russian literature.

4) Reports in Japan of *Navea subglobosa* Gray (a junior synonym of the eastern Pacific *Penitella conradi* Valenciennes, the abalone borer) may be referable to the second of the two species commonly cited as *P. kamakurensis*.

5) Modern and fossil specimens of *Penitella kamakurensis* of authors from the northeastern Pacific belong to another new species, this one characterized by a blunt-tipped shell that results from insertion against the lower part of a chimney very similar to that formed by *Parapholas californica* (Conrad).

6) In light of these nomenclatural changes, the zoogeographic ranges of most of the species of *Penitella* that occur around the margin of the north Pacific will need to be revised.

COMPARATIVE STUDIES IN TWO CO-OCCURRING SPECIES OF THE CHINK SNAIL *LACUNA*

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Lacuna marmorata Dall and *L. unifasciata* Carpenter are closely related gastropods that show several similar morphological and biological characteristics. In this study, snails from co-occurring populations in Monterey Bay, central California were examined to determine their distinguishing characters. Both species exhibited a variety of shell color patterns. A discriminant analysis test on shell morphology revealed that there is a 10% overlap between the species. Although most individuals showed species-specific characteristics in radular morphology, an intermediate form was found. Similarities in life history parameters include mode of reproduction and larval development; however, fecundity was significantly greater in *L. marmorata*. Although there was overlap in shell color patterns as well as shell and radular morphology, crossbreeding experiments confirmed that these species were reproductively isolated, indicating two separate biological species.

PATELLACEAN EVOLUTION

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[Abstract not submitted]

PALEONTOLOGY IN THE HIGH ARCTIC, ELLESMERE ISLAND, CANADIAN ARCTIC ARCHIPELAGO

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The most northerly sedimentary rocks that contain a well preserved Paleogene fauna of marine mollusks crop out on Ellesmere Island, Northwest Territories, Canada, at about latitude 80° N. These mollusks are found in the upper portion of the Eureka Sound Formation, which also contains strata as old as Late Cretaceous. The Eureka Sound Formation occurs extensively throughout the Canadian Arctic Archipelago and is thought to be about 4,000 m thick. A month-long paleontologic study of the formation was conducted in 1984 at Strathcona Fiord, west-central Ellesmere Island, where strata of the marine facies are about 1,000 m thick. Both marine and nonmarine facies of this formation are well exposed in a broad syncline and crop out extensively on the north and south shores of the fiord. The marine sedimentary rocks consist of poorly indurated sandstone and siltstone that are light brown and grey. These rocks contrast starkly with the dark brown and black sedimentary rocks of the underlying and overlying nonmarine deposits.

The Paleogene marine mollusks from Strathcona Fiord make up a shallow-water low-diversity fauna of probable temperate aspect. The shallowness of marine deposition is suggested by numerous carbonaceous laminae throughout the marine facies, as well as by the presence of underlying and overlying nonmarine deposits. The low-diversity temperate aspects of this molluscan fauna contrast with the highly diverse tropical aspects of the mollusks in Paleocene deposits of West Greenland and indicate the absence of a direct marine connection between these two regions. The Strathcona Fiord fauna is more similar in diversity and temperate aspect to the Paleocene molluscan faunas of northern Alaska and North and South Dakota. Faunas of these three areas are thought to have lived in an early Tertiary Arctic Ocean largely isolated from the world ocean, with no connection to the Pacific Ocean and only a shallow and perhaps intermittent connection with the Atlantic Ocean.

THE ARCHAEOGASTROPOD FAMILY ADDISONIIDAE DALL, 1882: LIFE HABIT AND REVIEW OF SPECIES

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The limpet family Addisoniidae Dall, 1882, is represented in the eastern Pacific by a new species found living within spent egg cases of two species of cat shark (family Scyliorhinidae) from depths of 153-174 m off southern California. All material was collected by Pat Brophy on trawling vessels. The shell is asymmetrical, with space for the large secondary gill on the right side. As in other members of the superfamily Lepetellacea, the gonad is simultaneously hermaphroditic. The occurrence in shark egg cases and the presence of an open seminal groove are newly reported here. The thin shell and the characteristic radular morphology, in which the tooth cusps have low relief, are adaptations to life within the egg cases upon which the limpets feed. Other species in the family are *A. lateralis* (Requien, 1848), from the eastern Atlantic, and *A. paradoxa* Dall, 1882, type species of

the genus, from the western Atlantic.

THE RASPBERRY HYDROID AND ITS NUDIBRANCH PREDATOR

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A cold, clean, current-swept rocky habitat off the northeastern end of Vancouver Island, British Columbia, is the location of a new hydroid and its nudibranch predator. The hydroid, family Tubulariidae, has multiple oral tentacles and a primitive stolonoid holdfast. Predators of this hydroid are an undescribed stenothoid amphipod, and an aeolid nudibranch that has characteristics of the Norwegian genus *Cuthonella*. The characteristics and taxonomic placement of the primitive genus *Cuthonella* are discussed in relation to this new species and recent taxonomic changes in the genus *Cuthona*.

FOSSILIZATION OF *ATURIA*, AN EXTINCT RELATIVE OF *NAUTILUS*

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Fossiliferous concretions, collected from the lower Miocene part of the Lincoln Creek Formation along the Columbia River near Knappton, Washington, weather out of a continuously moving landslide block and accumulate along the bank of the Columbia River. A molluscan fauna of 32 species has been recovered from these concretions. The most abundant mollusk, the nautiloid cephalopod *Aturia angustata* (Conrad, 1849), is related to the living chambered *Nautilus* and is represented by more than 200 specimens.

The shell chambers of almost every specimen of *Aturia* are partially or wholly filled, and the shell itself replaced, by calcite, barite and quartz. As soon as a shell of *Aturia* filled with enough water to lose its buoyancy, it sunk to the bottom and, in the case of specimens in the Lincoln Creek Formation, the body chambers quickly filled with fine-grained sand and silt; any chambers with breaks or punctures to the outside also were filled. Petrographic thin sections of *Aturia* specimens show a layer of calcite deposited on the inside walls of the shell. Once this encrustation of calcite was deposited, it preserved the shape of the chamber when the shell itself was dissolved. The encrustation of radial calcite completely fills the chambers in a few specimens. Other specimens contain small rhombohedral crystals of calcite grown on top of the encrustation. Some specimens have blocky calcite, which completely fills the chamber, deposited upon the radial calcite.

Some specimens contain barite that has been deposited in the chambers on top of the radial calcite encrustation, and some have quartz deposited in the chambers or filling the space once occupied by the shell. A thin section of one specimen reveals that all three minerals were deposited after the encrustation formed, and in the following sequence: blocky calcite, barite, and quartz.

The rocks at Knappton have been intruded by a basalt that is correlative with the Grande Ronde Basalt of the Columbia River plateau. The deposition of barite, previously not known to be associated with fossil mollusks in Tertiary rocks, and quartz may be related to hot solutions generated when the basalt intruded the sedimentary rocks.

THE TROPHIC ROLE OF *ASTRAEA UNDOSA* (WOOD)

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Little is known of the biology of *Astraea undosa* (Wood), although it is one of the most conspicuous gastropods found in southern California kelp bed communities. Laboratory aquaria studies on food preference have revealed that *A. undosa* prefers brown algae, primarily *Macrocystis pyrifera* (Linnaeus). This study provides *in situ* feeding data on a subtidal population of *A. undosa* and shows that *A. undosa* is a generalist herbivore.

Field investigations were conducted at Bird Rock in Isthmus Cove on Santa Catalina Island, off the coast of southern California. Subtidal algal cover was quantified at depths to 6 m, 10.5 m and 15 m. Observations of *in situ* feeding behavior were made by teams of divers at each of the three depth intervals. Feeding behavior (active or inactive) and algal associations were recorded for all *A. undosa* encountered.

Astraea undosa is a generalist herbivore and was observed feeding on crustose Corallinaceae (*Dictyopteris undulata*, *Zonaria farlowii*), upright Corallinaceae (*Colpomenia sinuosa*, *Phyllospadix* sp., *Halidrys dioica*), and Ralfsiaceae. Feeding time on any species was directly related to its abundance. Furthermore, *A. undosa* can and does feed on crustose coralline algae, especially in deep water where other food sources are scarce. This feeding habit has not been recorded in previous laboratory studies on *A. undosa*.

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ZOOGEOGRAPHY, COMPARATIVE ANATOMY, AND ECOLOGY OF *SONORELLA* IN NORTHWESTERN SONORA, MEXICO

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Biological information, including correlation with vegetation and substrate type, are being compiled in order to explain the distribution of species in the land snail family Helminthoglyptidae in Sonora, Mexico. Field trips to the south, central, and west-central parts of Sonora have been made to date. As a result, two new species of *Sonorella* were recorded, one from Sierra El Viejo and one from Sierra Pico.

The shells were measured, and the reproductive systems were extracted and mounted on permanent slides. The external features of both species were described, as well as their reproductive systems. Some ecological features of the type localities are being analyzed.

WAS *MYA ARENARIA* TO BLAME FOR THE DECLINE IN PHYTOPLANKTON BIOMASS IN NORTHERN SAN FRANCISCO BAY DURING THE 1976-77 DROUGHT?

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Abundance data and computed filtration rates suggest that the upstream migration of *Mya arenaria* Linnaeus during the prolonged period of high salinity could have accounted for the planktonic ecosystem changes that occurred in northern San Francisco Bay during the 1976-77 drought.

FOSSIL DEPOSITS OF THE GALAPAGOS ISLANDS

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[Slide presentation, abstract not submitted]

**AMINO ACID COMPOSITION OF PLEISTOCENE BIVALVES:
PRELIMINARY RESULTS FROM THE SAN PEDRO AREA, CALIFORNIA**

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Preliminary results of quantitative amino acid analyses on 39 specimens of bivalves from Pleistocene deposits in the San Pedro area of southern California suggest the following: 1) The total amino acid compositions of the 6 genera used in this study are distinctive enough to form patterns that can be used to readily identify the genera; this is done by using the method of linear discriminant analysis [Andrews *et al.*, 1982, *Geol. Soc. Amer., Abstr. w. Prog.*, 14(7):433-434]. 2) Genera belonging to different families have amino acid compositions that differ more than the amino acid compositions of genera within the same family. 3) The extent of epimerization of isoleucine, or AlIe:Ile , for a sample of given age is genus dependent and appears to correlate most strongly with the percent of leucine in the shell.

Genera and species analyzed in this study were *Chione undatella* (Sowerby), *Protothaca staminea* (Conrad), *Saxidomus nuttalli* Conrad, *Tivela stultorum* (Mawe) (family Veneridae); *Macoma nasuta* (Conrad) (family Tellinidae); and *Panopea generosa* (Gould) (family Hiatellidae). The samples range in age from late Pleistocene (approx. 125,000 yr. B. P.) to early Pleistocene (approx. 750,000 yr. B. P.). Ninety-seven percent of the specimens were identified correctly by using concentrations of individual amino acids and selected amino acid ratios as variables in a stepwise linear discriminant analysis. Furthermore, the analyses show that the amino acid assemblages of Hiatellidae (*Panopea*) and Tellinidae (*Macoma*) are distinguishable and have more distinct amino acid patterns than those of the Veneridae (*i.e.*, *Tivela*). The most important variable for discriminating genera is the ratio of allosioleucine + isoleucine to valine. Among only the venerids, the ratio of aspartic acid to glutamic acid and the concentration of allosioleucine + isoleucine are the best discriminators.

In samples from the San Pedro Sand (approx. 250,000(?) yr. old), the extent of epimerization of isoleucine is greatest in *Macoma* ($\text{AlIe:Ile} = 0.67$) and least in *Tivela* ($\text{AlIe:Ile} = 0.50$). Multiple regression analysis indicates that a strong positive correlation exists between the extent of epimerization and the percent of leucine present within the shell ($R^2 = 0.88$).

**A MIDDLE-AMERICAN LAND SNAIL FAUNA
FROM THE EOCENE-OLIGOCENE OF TEXAS**

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An undescribed large helminthoglyptid snail of the genus *Lysinoe* occurs in the Colmena Tuff and Chambers Tuff of the Vieja Group, Presidio County, Texas, and is associated with vertebrates of the Candelaria and Porvenir local faunas. *Lysinoe* is also present in correlative strata in Brewster County, Texas, and in a predominantly marine sequence in Nuevo Leon, Mexico, that is associated with a "Vicksburg" molluscan fauna. The vertebrate assemblages belong to the Uintan and

Chadronian North American Land Mammal "Ages". Radioisotopic dates indicate a time span of about 41 to 38 million years before present. The species closely resembles Recent *Lysinoe ghiesbreghtii* (Nyst) from southern Mexico and Central America. Climatic and ecological parameters from the range of *L. ghiesbreghtii* imply that conditions in this part of Texas during the late Eocene-early Oligocene were moist and temperate; the prevailing vegetation was probably an ecological analogue of the seasonal temperate forests of present-day Chiapas, Mexico. Mean annual rainfall in excess of 123 cm, either with or without a winter dry season, is indicated. Many plant species of temperate Mexican forests have counterparts in the southeastern United States; *Lysinoe* supports the concept of a formerly continuous forest distribution around the northwestern Gulf of Mexico.

The Candelaria local fauna also includes the helminthoglyptid genus *Polymita*, now confined to Oriente Province, Cuba. Other land snails from the Chambers Tuff include two subgenera of *Pleurodonte* (Camaenidae), now confined to Jamaica and the Lesser Antilles, and *Xerarionta* (Helminthoglyptidae), now living from southern California to southern Baja California. *Polymita* and *Pleurodonte* both now inhabit more tropical forests than *Lysinoe*. *Xerarionta* inhabits arid and semiarid zones within the influence of Pacific fog. Climatic equability may have permitted the co-occurrence of genera that now show conflicting climatic preferences. The snail assemblages document a southward retreat of land mollusk genera through the Tertiary, and a developing allopatry.

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COLLECTING MOLLUSKS IN THE ALASKAN ARCTIC

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[Slide presentation, abstract not submitted]

COCOS ISLAND, COSTA RICA: AN INDO-PACIFIC — PANAMIC BRIDGE

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[Slide presentation, abstract not submitted]

UPDATE ON MOLLUSKS WITH INDO-PACIFIC FAUNAL AFFINITIES IN THE TROPICAL EASTERN PACIFIC III

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During March, 1984, I was again able to SCUBA dive at Cocos Island, Costa Rica, along with Gene Everson of Ft. Lauderdale, Florida. This year three additional Indo-Pacific species were found at Cocos Island that have not been previously reported from the tropical eastern Pacific. They are: *Metaxia brunnicephala* Kay, 1979, *Cymatium nicobaricum* Roeding, 1798, and *Mitra ferruginea* Lamarck, 1811. Our work at Cocos Island will continue in 1985.

A SELECTION OF COMMON SOUTHERN CALIFORNIAN JUVENILE MOLLUSKS

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Juvenile mollusks may differ from adults in several ways and often lack features that are diagnostic of the adult form. For instance, juvenile abalones, keyhole limpets, and *Sinezona* lack the holes that are present in the adult shell. Changes in color often occur between juvenile and adult shells. Immature *Haliotis cracherodii* Leach have a coloration of mottled pinks and whites before changing to the black tones of the adult. *Chama arcana* Bernard is unusual in that it has a pink prodissoconch; many small shells and prodissoconchs are white. A variety of color changes occurs in the family Calyptraeidae and involves different combinations of a white background with brown streaks and dots.

Changes in sculpture are as common as changes in color and a striking example is *Glans subquadrata* (Carpenter). In the adult, the umbones are well to the anterior of the shell, but the prodissoconchs of the larval shell are centrally located and are so thickened that they create a raised platform. Sometimes changes in sculpture can be so complete that the adult shell is in no way a logical progression of the larval shell, as in *Philobrya setosa* (Carpenter). Some members of the Vermetidae can change dramatically also, starting with a tight, regularly coiled protoconch before producing the irregular, loosely coiled whorls of the adult. A variety of changes occur in the Mytilidae. Sometimes juveniles lack distinguishing characteristics, but occasionally immature specimens are easier to identify than adults.

ABUNDANCE OF TURRITELLIFORM GENERA THROUGH THE PHANEROZOIC: ANOTHER PREDATION-RELATED PATTERN?

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The relative frequencies of different prosobranch shell shapes have changed throughout the Phanerozoic, due at least in part to changes in the intensity of shell-crushing or durophagous predation. For example, Vermeij [1978, *Biogeography and adaptation*] has documented a decrease in numbers of gastropods with disjunct or planispiral coiling during the mid-Mesozoic radiation of durophagous predators. This, and other predation-related events in the mid-Mesozoic, have come to be known as the Mesozoic marine revolution.

A similar series of events occurred in the mid-Paleozoic. There was a radiation of durophagous predators and a concurrent increase in predation-resistant morphologies among members of the marine benthos. For example, spinosity increased among brachiopods and camerate crinoids, and sculpture increased among coiled nautiloids and bellerophonitid mollusks. At the same time, there was a surprising increase in the relative frequency of high-spired or turritelliform prosobranch genera. Is it likely that the two events were related?

Experiments with *Calappa hepatica*, a modern durophagous crab, and terebrid gastropods demonstrate that very slender, high-spired gastropods are less susceptible to shell-peeling crabs than less high-spired forms. Successful attacks occurred on very slender terebrid gastropods (*Terebra kilburni*, *T. laevigata*, *T. subulata*) in less than 1% of the trials. Successful attacks on less slender terebrids (*Terebra affinis*, *T. areolata*, *T. columellaris*, *T. conspersa*, *T. dimidiata*, *T. undulata*) were

more frequent but still far less common than on other geometries as reported by Vermeij (1978).

Whereas no experimental data are available on interactions between shell crushers (mainly fish) and gastropods, there are functional reasons to suspect that shell crushers may have difficulty attacking spike-like turritelliform shells. Fish lack a flexible, mobile tongue that would enable them to manipulate prey into a position for crushing. The elongate form of turritelliform shells may obstruct successful attacks by these predators.

Therefore, it seems reasonable to interpret the increased numbers of turritelliform genera in several gastropod clades, beginning in the Devonian, as a response to an increasing number of durophagous predators. The sharp decline in planispiral bellerophonitid genera in the Late Devonian likely is also a result of an increased intensity of durophagous predation.

Data on the frequency of shell shapes through the Mesozoic are not available at this time, but if the foregoing conclusions are correct, then a similar increase in numbers of turritelliform snails should have occurred in the mid- Mesozoic.

RECENT DEVELOPMENTS AND RESEARCH OPPORTUNITIES IN ELKHORN SLOUGH

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[Abstract not submitted]

THE INTERTIDAL SNAILS OF PANAMA CITY: AN EXCEPTIONALLY DIVERSE NEARSHORE ASSEMBLAGE

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The first extended study of the shelled gastropods from a tropical rocky shore has revealed an exceptionally diverse fauna, comparable to that typically associated with coral reefs. Some 350 different species of snails were collected intertidally, including 70 from particulate substrates. Including these, nearly 500 species have been reported from rock, cobble, sand, mud and mangrove habitats on the Pacific Ocean shore in the limited area around Panama City, Republic of Panama. The number of species will increase when adequate collections are made from the subtidal fringe and specialized habitats, and of microgastropods in general. The subtidal fauna is probably rich as well, indicating that some 900 species of snails form the functioning ecological assemblage in this limited area. This assemblage is nearly an order of magnitude more diverse than any previously studied rocky shore fauna.

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THE MONTEREY BAY AQUARIUM: A WINDOW INTO MONTEREY BAY

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[Invited Banquet presentation]

STUDIES ON DISTRIBUTION, DEGREE OF AERIAL EXPOSURE, AND COMPETITIVE INTERACTIONS IN FOUR SPECIES OF TROPICAL INTERTIDAL GASTROPODS

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The vertical distributions of the limpet *Acmaea jamaicensis* (Gmelin) and the littorines *Nodilittorina tuberculata* (Menke), *N. ziczac* (Gmelin) and *Littorina meleagris* Potiez & Michaud were investigated on a vertical limestone block on the west coast of Barbados, West Indies. Three experimental plots and one control plot were fenced off on the limestone block. In each of the experimental plots all gastropods except for one species of littorinid (a different species in each plot) were removed. The control plot contained the natural density of all species of gastropods. Significant differences in distributional patterns were recorded between the experimental and control plots after a 20-day period. The distributional pattern of *L. meleagris* was also shown to differ significantly when it was living sympatrically with different experimental densities of *A. jamaicensis*, whereas reciprocal effects of *L. meleagris* on *A. jamaicensis* were not noted. Both sets of experimental data indicated the existence of interspecific competition among the 4 species of gastropods. In addition, variation among the three littorinids pertaining to functional morphology of the mantle cavity, and survival in air and water were investigated, and the significance of these findings to the vertical distributional patterns of the 4 species was discussed.

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Extended Abstracts

ANTARCTIC OPISTHOBRANCHS: A PRELIMINARY REPORT ON SPECIMENS COLLECTED BY THE UNITED STATES ANTARCTIC RESEARCH PROGRAM

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The Smithsonian Oceanographic Sorting Center of the U.S. National Museum of Natural History is responsible for the worldwide distribution of specialized collections of marine organisms to specialists everywhere. Through the Sorting Center, I was able to borrow for study the entire collection of opisthobranch gastropods collected between August 1962 and April 1983 by the Antarctic Research Vessels Hero, Isas Orcada, and Eltanin and operating under the auspices of the United States Antarctic Research Program (USARP).

All of the specimens were collected in the Scotia, Weddell, and Bellingshausen Seas between 25° and 80° west longitude, and on either side of the Antarctic Peninsula as far north as the southern tip of South America (figs. 1-6). The material consists of 456 specimens in 146 sample lots representing seven major taxonomic groups in the Opisthobranchia (table 1). Most of the collections were made during the austral summer. The number of subtidal stations that yielded opisthobranchs can be broken down by season: 77 stations yielded opisthobranchs in the period January through March, 47 from April through June, 8 from July through September, and 14 from October through December. Absence or paucity of individuals in lots collected during July to December merely reflects this seasonal collecting bias and precludes any biological-seasonal analysis.

This study is still in its early stages, mainly because the dissection of each specimen, required for species-level identification, has not been completed. Sufficient data do exist, however, to make some preliminary observations herein on Antarctic opisthobranch abundances, distribution, and feeding biology. Other studies in progress include implications about nudibranch phylogeny based on gnathodorid dissections (Bertsch and Ghiselin, 1985), description of a new species of *Bathyberthella*, and a comparative study and revision of the genus *Bathydoris*.

The 456 Antarctic opisthobranchs are distributed among 7 major taxonomic groups (table 1). The cryptobranch dorid nudibranchs and the shelled cephalaspideans are the largest groups represented, followed by the dendronotid nudibranchs and notaspideans which are present in nearly equal numbers. The fifth group, the primitive gnathodorid nudibranchs, is represented by the genus *Bathydoris*. Finally, several eolids and a few arminid nudibranchs are present also. The arminids occur in such low numbers that they will not be considered in most of my analyses.

These taxonomic groups are very unevenly distributed among the 146 samples (table 1). Average sample sizes for the cephalaspideans and cryptobranchs were 4.83 and 2.77 respectively (per lot in which the taxon occurred). Other groups usually were represented by single specimens. In samples that contained members of a particular group, sample sizes averaged 1.33 for eolids, 1.38 for gnathodorids, 1.48 for notaspideans, and 1.75 for dendronotids. Although cryptobranchs and cephalaspideans were the most common opisthobranchs, cryptobranchs and dendronotids occurred in the greatest number of samples.

The major taxonomic groups show different geographic distributional patterns (figs. 1-6). (The lower right hand corner of each map represents the South Pole, and the odd-shaped areas are diagrammatic representations of the southern tip of South America, and of west Antarctica and the protruding Antarctic Peninsula). The average latitude where the specimens were collected varies from 54° S to 60° S. (table 2). The eolids occur farthest north and do not have a true Antarctic distribution. The majority of the eolids were collected around Punta Arenas and the islands around the tip of South America.

The bathymetric distribution of Antarctic opisthobranchs is summarized in table 3 and figure 7. The shallowest subtidal collecting depth was 14 m, and the deepest 5929 m. The median depth of occurrence for each group is shallower than the mean depth and also is more representative of

preferred depth of the animals because several extremely deep records will bias the mean depths.

Figure 7 illustrates the bathymetric distribution of the major opisthobranch groups in the Antarctic. The relative width of the diagrams represents the number of specimens. Most of the cryptobranchs, cephalaspideans, dendronotids, and eolids were collected in less than 300 m depths. However 45% of the cephalaspideans with depth data were collected at greater depths, as were the majority of notaspideans and gnathodorids. The mean depths of the latter were 651 and 1078 m, respectively; the median depths of both were greater than 400 m.

The Antarctic opisthobranchs show some interesting zoogeographic differences of taxa occurrence between different faunal provinces (table 4). Data for the non-Antarctic regions were taken from Bertsch and Johnson (1983). In California 80% of the opisthobranch species are nudibranchs and 10% are cephalaspideans. In the Panamic province 50% of the known opisthobranchs are nudibranchs and 30% are cephalaspideans. The two dominant orders in Japan are sacoglossans and nudibranchs. All three of these areas have representatives of the 5 major opisthobranch orders. The Antarctic material, however, contains only cephalaspideans, notaspideans, and nudibranchs; sacoglossans and anaspideans are absent.

The contrast between different zoogeographic provinces is even more striking when one examines the four evolutionary lineages of dorid nudibranchs (table 5). In the Californian, Panamic, and Japanese provinces, porostomes represent 3-5% of all opisthobranch species and phanerobranchs 7-16%. Both of these groups are absent in the Antarctic material. In contrast, cryptobranchs represent 39% of the Antarctic opisthobranchs, whereas they represent only 18-22% of the opisthobranch species in the other three provinces. The gnathodorids are deep-water species and are very rare in the Californian faunal province; they are absent in Japan and in the Panamic province. Gnathodorids represent 4% of the USARP opisthobranch specimens.

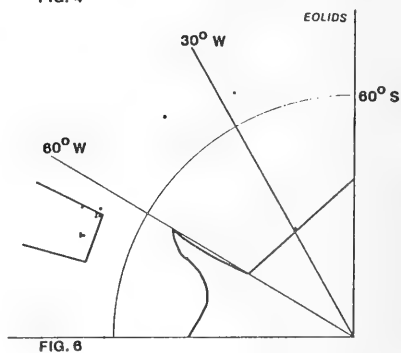
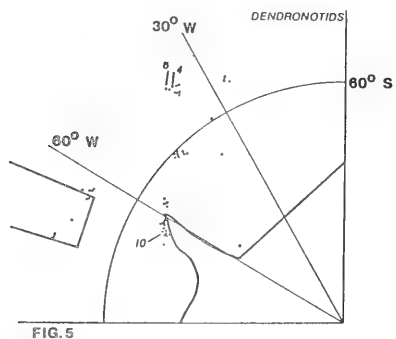
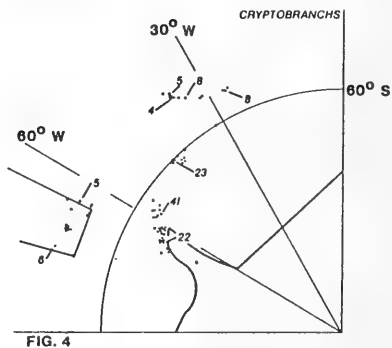
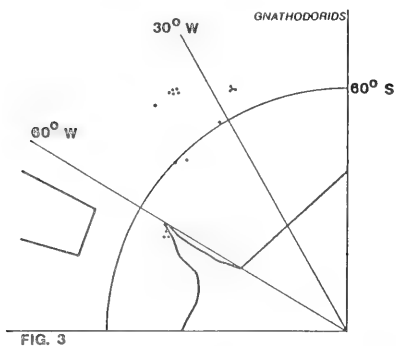
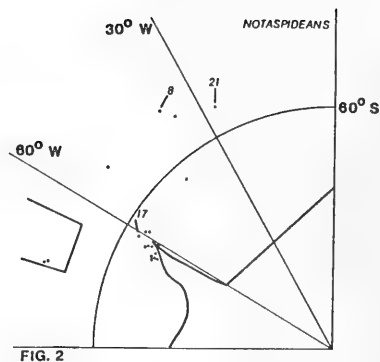
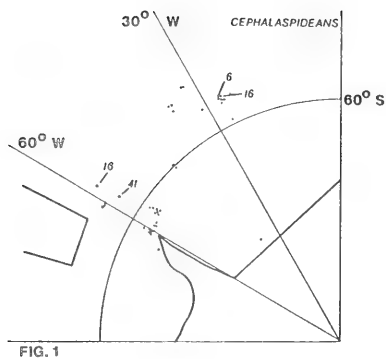
The zoogeographic-taxonomic differences are reflected also in the feeding habits of the Antarctic specimens (table 6). There are no known bryozoan nor tunicate feeders, no herbivores, and anemone feeders are scarce. The taxonomic groups of opisthobranchs that are absent in the Antarctic are phanerobranchs, sacoglossans and anaspideans; eolids are quite rare. The general scavengers or opportunist carnivores are mainly the cephalaspideans, and probably the notaspideans; sponge feeders are represented by the cryptobranch dorid nudibranchs; and cnidarian predators, the gnathodorids and dendronotids, eat hydroids, antipatharians, and alcyonarians. The notaspideans may possibly feed on sponges and cnidarians.

Gordon Hendler, Smithsonian Oceanographic Sorting Center, kindly arranged for the loan of Antarctic opisthobranchs; Anthony D'Attilio provided laboratory facilities at the San Diego Natural History Museum.

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[Figures and tables follow on next three pages]



Figures 1-6. Geographic distribution of USARP opisthobranchs. 1. Cephalaspideans; 2. Notaspideans; 3. Gnathodorids; 4. Cryptobranchs; 5. Dendronotids; 6. Eolids.

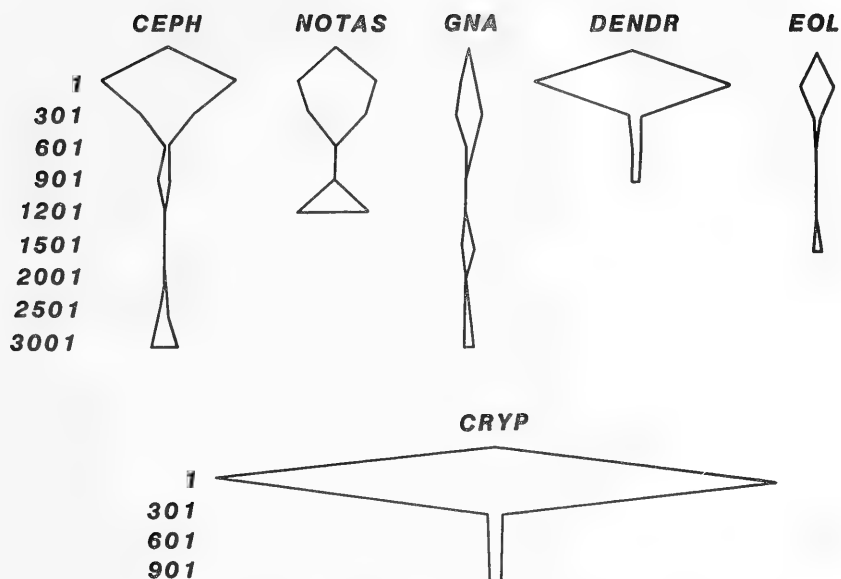


FIG.7 BATHYMETRIC DISTRIBUTION(m)

Figure 7. Bathymetric distribution of USAEP opisthobranchs; depths in meters. Ceph, Cephalaspideans; Notas, Notaspideans; Gna, Gnathodorids; Dendr, Dendronotids; Eol, Eolids; Cryp, Cryptobranchs.

TABLE 1
Taxa Occurrence in Opisthobranch-Yielding Samples (146)

	Number of Samples	Percent total samples	Number of specimens	Percent of total
Cephalaspideans	24	16	116	25.4
Notaspideans	25	17	62	13.5
Gnathodorids	13	9	18	3.9
Cryptobranchs	65	44	180	39.4
Dendronotids	37	25	65	14.2
Arminids	2	1	3	0.65
Eolids	9	6	12	2.6
			<hr/> 456	<hr/> 99.65

TABLE 2

Geographic Distribution

Average ° S latitude	
Eolids	54
Cephalaspideans	56
Gnathodorids	56
Notaspideans	58
Dendrontids	59
Cryptobranchs	60

TABLE 3

U.S.A.R.P. Opisthobranch Bathymetric Distribution

depths in meters	Mean	Median
Cryptobranchs	144	104
Eolids	274	123
Dendronotids	182	124
Cephalaspideans	833	156
Notaspideans	651	423
Gnathodorids	1078	441

TABLE 4

Percentage of major opisthobranch groups
in different zoogeographic provinces

	% species			% of specimens Antarctic
	Calif	Panamic	Japan	
Cephalaspideans	10	31	3	25
Anaspideans	2	6	6	--
Sacoglossans	5	9	9	--
Notaspideans	3	4	2	14
Nudibranchs	80	50	79	61

TABLE 5

Provincial distribution of dorid nudibranch
lineages by zoogeographic province

	% species			% of specimens Antarctic
	Calif	Panamic	Japan	
Gnathodorids	1	--	--	4
Cryptobranchs	19	18	22	39
Porostomes	4	3	5	--
Phanerobranchs	16	7	12	--
% of total opisthobranchs				

TABLE 6

Feeding preferences of Antarctic opisthobranchs

General scavenger or opportunistic carnivore	Sponges	Cnidarians
Cephalaspideans	Cryptobranchs	Gnathodorids
Notaspideans (?)		Dendronotids
		Arminids
		Eolids

**MOLLUSKS AND OTHER INVERTEBRATES
OBSERVED AT PUNTA BAJA, BAJA CALIFORNIA, MEXICO**

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Observation and collections of shallow-water marine invertebrates, mostly mollusks, were made in the vicinity of Punta Baja, Baja California, Mexico, on June 29, 30, and July 1, 1984, during pre-dawn ebb tides. Punta Baja is located approximately 360 km, by road, south of the U.S.-Mexico border. Observations were made in rocky habitats on the windward side of the tip of Punta Baja, and at a location approximately 1.6 km east of the point. Water temperatures recorded in the tidepools were 15 and 16°C. The intertidal zone at Punta Baja can be divided into 3 zones that differ mainly in the nature of their algal cover. The uppermost is a 7-8 m wide zone of the red alga *Porphyra*. The lowermost zone is dominated by *Phyllospadix*, *Egregia*, *Ulva*, and *Gigartina*. In the zone between these, the red alga *Gigartina* predominates.

The following invertebrates were observed and (or) collected at Punta Baja and vicinity:

MOLLUSCA: GASTROPODA

Acanthina spirata (Blainville 1832); on windward side of point.

Acanthodoris rhodoceras Cockerell, in Cockerell & Eliot, 1905; 5 specimens from 7 to 20 mm in length, from east of point.

Aeolidia papillosa (Linnaeus, 1761); 1 specimen 17 mm long, under a rock with 25 *Fissurella volcano*.

Aplysia californica Cooper, 1863; 30 specimens ranging from 23 to 30 cm in length, on both sides of point. One egg mass consisted of multi-colored strings.

Aplysia vaccaria Winkler, 1955; 40 specimens ranging from 15 to 30 cm in length, on both sides of point. The largest specimens collected in December 1983 were 8 cm long.

Astraea undosa (Wood, 1828); 1 small live specimen.

Coryphella trilineata O'Donoghue, 1921; in rocky habitat 1.6 km east of point.

Dendrodoria fulva MacFarland, 1905; 6, on both sides of the point.

Dendronotus subramosus MacFarland, 1966; 1, east of point.

Dirona pictura MacFarland, in Cockerell & Eliot, 1905; 24 specimens from 10 to 33 mm in length.

Fissurella volcano Reeve 1849; vast numbers with up to 30 under a single rock; shells up to 30 mm long. The form *F. v. "crucifera* Dall" is less common.

Haminoea virescens (Sowerby, 1833); 14 specimens, from both collecting stations. Seven specimens were associated with a yellow coiled-ribbon egg mass on the underside of 1 rock.

Hermisenda crassicornis (Eschscholtz, 1831); specimen with atypical coloration.

Kelletia kelletii (Forbes, 1852); 1 live specimen 52 mm long, on windward side of point.

Soft parts of the animal are bright yellow, with 2 color bands, and white spots.

Macron lividus (A. Adams, 1855); 2, east of point.

Nayanax inermis (Cooper, 1863); 3 specimens, 20, 30, and 60 mm in length, from windward side of point.

Norrisia norrisi (Sowerby, 1838); common live on windward side of point; the shells are pitted from the rough conditions.

Olivella biplicata (Sowerby, 1825); several, east of point.

Phidiana hiltoni (O'Donoghue, 1927); 6 in tidepools and 1 upside down on under surface of water.

Rostanga pulchra MacFarland, 1905; 8 specimens from 7 to 13 mm in length; red sponges not observed in vicinity.

Spurilla oliviae (MacFarland, 1966); 3 specimens, under rocks with *Fissurella volcano*.

Tegula aureotincta (Forbes, 1852); shell covered with limpets.

Tegula funebris (A. Adams, 1855); numerous, on both sides of point.

MOLLUSCA: BIVALVIA

Chaceia ovoidea (Gould, 1851) or *Zirfaea pilsbryi* Lowe, 1931; an area 1.6 km east of the point had at least 65 piddock siphons protruding above a substrate of red mudstone with a covering of fine sand. The large size of the siphons (1 was 25 mm by 18 mm in diameter with an excurrent siphon 14 mm by 7 mm), suggests *Chaceia* or *Zirfaea* rather than *Penitella*, but specimens were not collected. The siphons extend about 25 mm above the sand and, when disturbed, shoot streams of water a good distance above the bottom.

MOLLUSCA: CEPHALOPODA

Octopus sp. cf. *O. bimaculatus* Verrill, 1883; 12 animals, the largest measuring 18 cm from arm tip to arm tip.

ANNELIDA: POLYCHAETA

Cirriformia spirabrancha (Moore, 1904); many together, oriented vertically in sand with branchiae above sediment-water interface.

Phragmatopoma californica (Fewkes, 1889); several small "reefs" of this colonial tube worm observed east of the point. Wave action shears off the tube lips, giving the colonies a smooth appearance.

COELENTERATA: ANTHOZOA

Anthopleura xanthogrammica (Brandt, 1835); large numbers; 1 specimen was 10 cm high and 17.5 cm across.

ANTHROPODA: CRUSTACEA

Crangon sp.; on sand bottoms. This shrimp moves its legs and body in such a way as to bury itself under the sand, leaving only its eye stalks above the surface to look out for other organisms.

Pleuroncodes planipes Stimpson, 1860; 1 specimen, on windward side of point.

Shrimp; in rocky tide pool 1.6 km east of point.

ECHINODERMATA: ASTEROIDEA

Pisaster ochraceus (Brandt, 1835); on both sides of point.

ECHINODERMATA: ECHINOIDEA

Strongylocentrotus franciscanus (A. Agassiz, 1863); hundreds of specimens, on windward side of point.

Strongylocentrotus purpuratus (Stimpson, 1857); thousands of specimens, only on windward side of point, where it occupies up to 90% of some tidepools. In one area, a large number had empty, concave-upward valves of *Mytilus californianus* Conrad, 1837 attached aborally.

ECHINODERMATA: HOLOTHUROIDEA

Leptosynapta albicans (Selenka, 1867); several specimens of this sea cucumber were present under rocks east of the point.

BIVALVE MOLLUSCAN PALEOECOLOGY OF NORTHERN EXPOSURES OF THE MARINE NEOGENE IMPERIAL FORMATION IN RIVERSIDE COUNTY, CALIFORNIA

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INTRODUCTION

The marine Imperial Formation was deposited at the head of the proto-Gulf of California during the latest Miocene through late(?) Pliocene time. The formation crops out discontinuously northward from just south of the California-Mexico border to San Geronio Pass, Riverside County, California. Exposures of the Imperial Formation in Riverside County occur along the San Andreas-Banning fault zone. Important exposures occur at Lions Canyon, Super Creek, Garnet Hill, Edom Hill and Willis Palm (fig. 1). The faunas from Super Creek, Garnet Hill and Willis Palm each represent different environments and form the basis for this note. The Imperial Formation in Riverside County attains a maximum thickness of 105 m and is divided into two members separated by a time transgressive boundary from north to south.

The lower, Latrania Sand Member (Keen and Bentson, 1944), whose type section is in Imperial County, is generally composed of coarse- to medium-grained sandstone with scattered conglomeratic beds; it attains a maximum thickness of 30 m in Riverside County. The molluscan assemblage from the Latrania Sand Member in Riverside County is characterized by species that lived in a euhaline, moderate- to high-energy, intertidal(?) to inner shelf, rocky to sandy habitat. Taxa that commonly occur in Riverside County include *Spondylus victoriarum* (Sowerby), *Pycnodonte heermanni* (Conrad) [= "*Ostrea*" *heermanni* Conrad], *Dendostrea angelica* (Rocheburne), and *Argopecten* spp. (pl. 1).

The unnamed, upper member of the Imperial Formation is about 75 m thick in Riverside County. In this area it represents a low- to moderate-energy, outer shelf facies and is composed of medium- to fine-grained sandstone and siltstone. Characteristic bivalve mollusks in this member in Riverside County include *Cyclopecten* sp. cf. *C. pernomus* (Hertlein), *Dendostrea vespertina* (Conrad), and *Anomia peruviana* d'Orbigny (pl. 1).

PALEOECOLOGY Super Creek Area

Both members of the Imperial Formation are exposed along Super Creek. The Latrania Sand Member occurs in small discontinuous synclines (fig. 2), and appears to have been deposited in small pocket beaches in rocky headlands. The outcrops are characterized by abundant *Spondylus victoriarum* and *Dendostrea angelica* that are found attached to large clasts in conglomeratic stringers. Bernard (1983) reports *D. angelica* in water depths of 1 to 5 m and *S. victoriarum* from 10 to 40 m. Thus the Latrania Sand Member along Super Creek was probably deposited in shallow subtidal depths that deepened upsection to between 10 and 40 m at the top of the member. These beds are overlain by a 70- cm thick "worm tube" marl at the top of the Latrania Sand Member. The environment of deposition of the marl was not determined because of the poor preservation of its fossils.

The Latrania Sand Member is overlain by medium- to fine-grained sandstone and siltstone of the unnamed upper member. About 10 m above the top of the Latrania Sand is a bed of *Atrina* n. sp. preserved in life position. *Atrina* is found in water depths from 1 to 125 m in the eastern Pacific, but only *A. texta* Hertlein & Strong, is reported to occur below 30 m. Benthic foraminifers from this bed suggest inner neritic water depths (0-50 m) (K. A. McDougall, written commun., 1981). Together these data suggest water depths of less than 50 m for the lower part of the unnamed upper member of the Imperial Formation. Near the top of the upper member, *Cyclopecten* sp. cf. *C. pernomus* and many shell fragments have been concentrated into small shell lag deposits, possibly by currents. Water depth during deposition of this unit is unclear, but the

occurrence of *C. sp. cf. C. pernomus* limits the depth to 355 m (Bernard, 1983). Benthic foraminifers throughout the upper member indicate that water depths increase to middle and outer neritic depths (50-150 m) near the top of the formation (K. A. McDougall, written commun., 1981).

In the Super Creek area, the Imperial Formation is overlain by medium- to coarse-grained sands and conglomeratic beds of the Painted Hill Formation, previously interpreted as alluvial fan deposits by Allen (1957). The interfingering of the Painted Hill Formation with neritic silts of the Imperial Formation indicates that the base of the Painted Hill Formation probably is not of alluvial fan origin.

Garnet Hill Area

About 17 m of the Latrania Sand Member are poorly exposed on Garnet Hill. These beds are composed of coarse- to fine-grained sandstone with abundant gneissic and marble clasts as much as 2 m in diameter. Some of these clasts have been bored by lithophagid bivalves (identified by G. L. Kennedy, oral commun., 1984). Also present on some of the clasts are poorly preserved specimens of *Spondylus* sp. and *Dendostrea* sp. cf. *D. angelica*. *Pycnodonte heermanni* is abundant as float on the south slope of Garnet Hill. These species, although inconclusive as to their environmental parameters, suggest shallow water depths with at least some areas of exposed rocks.

Willis Palm Area

The Imperial Formation at Willis Palm consists of about 53 m of generally fine-grained sandstone and siltstone. Three shell beds are exposed in this section. The first contains unidentifiable mollusk fragments, crab chelipeds, and the gastropod *Melampus* sp., which suggests a salt marsh environment. About 2 m above this bed is a 2-m-thick oyster bioherm composed of flat to slightly plicate *Dendostrea? vespertina*. This bioherm suggests a moderately shallow bay or lagoonal environment. The third shell bed, about 15 m above the base of the formation, is 20 cm thick and composed of abundant well preserved shells. This bed is characterized by the bivalve mollusks *Leptopecten palmeri* (Dall), *Cyclopecten* sp. cf. *C. pernomus*, *Cyrtopleura costata* (Linnaeus), and abundant corbulids. These species suggest shallow water depths between 1 and 90 m. Benthic foraminifers from this section indicate shallow water (K. A. McDougall, written commun., 1984). Fossils from throughout the Willis Palm section indicate that water depths increased from very shallow inner neritic (< 10 m) at the first shell bed to a maximum depth of inner neritic (10 - 50 m) just above the top shell bed, and then shallowed to less than 10 m at the top of the formation.

CONCLUSIONS

Other exposures of the Imperial Formation are present in Riverside County but were either inaccessible during the present study (Lions Canyon) or contained such a meager fauna that paleoecological analysis was impossible (Edom Hill).

The sections at Super Creek and Garnet Hill appear to be older than those exposed at Willis Palm. These relative-age estimates are based on biostratigraphic data and on an unpublished K/Ar date on a basalt flow in the Painted Hill Formation along Super Creek (J. C. Matti, personal commun., 1984). The Super Creek section seems to represent a deepening basin: the intertidal or shallow subtidal rocky shore facies of the Latrania Sand Member at the base of the formation grades into middle and outer neritic fine-grained continental-shelf facies of the upper member at the top of the formation. Sediments exposed at Garnet Hill appear to represent the same environment as represented by the Latrania Sand Member at Super Creek. The Willis Palm section represents a transgressive-regressive sequence starting with a salt marsh environment, which grades upsection into a shallow lagoon or bay, characterized by an oyster bioherm. This is followed further upsection by a slightly deeper, possibly open marine environment, which again changed to shallow or possibly intertidal depths at the top of the formation.

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- Bernard, F. R., 1983. Catalogue of the living Bivalvia of the eastern Pacific Ocean: Bering Strait to Cape Horn. *Canadian Special Publication of Fisheries and Aquatic Sciences*, 61: 1-102.
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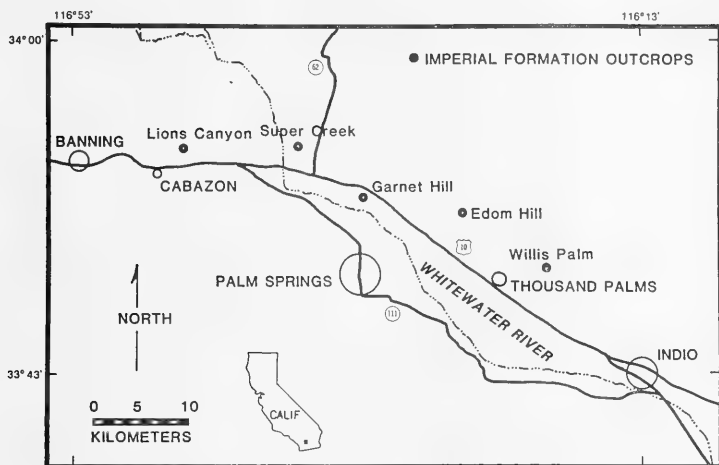


Figure 1. Index map showing localities of the Imperial Formation in the study area.

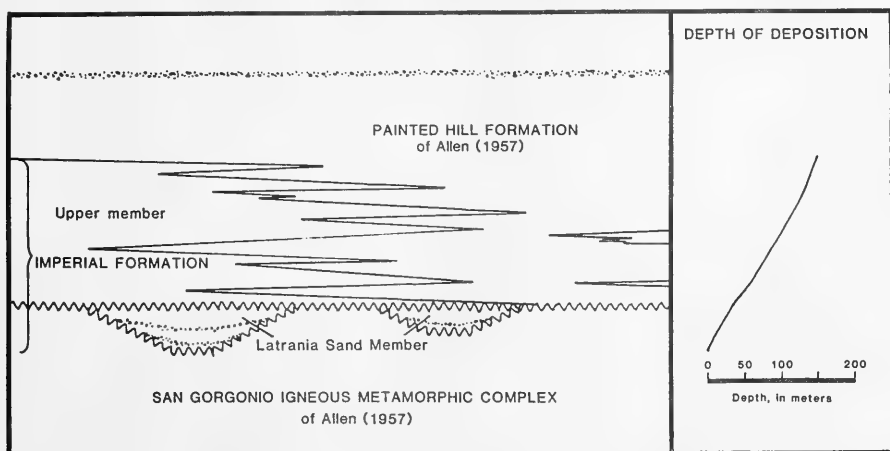
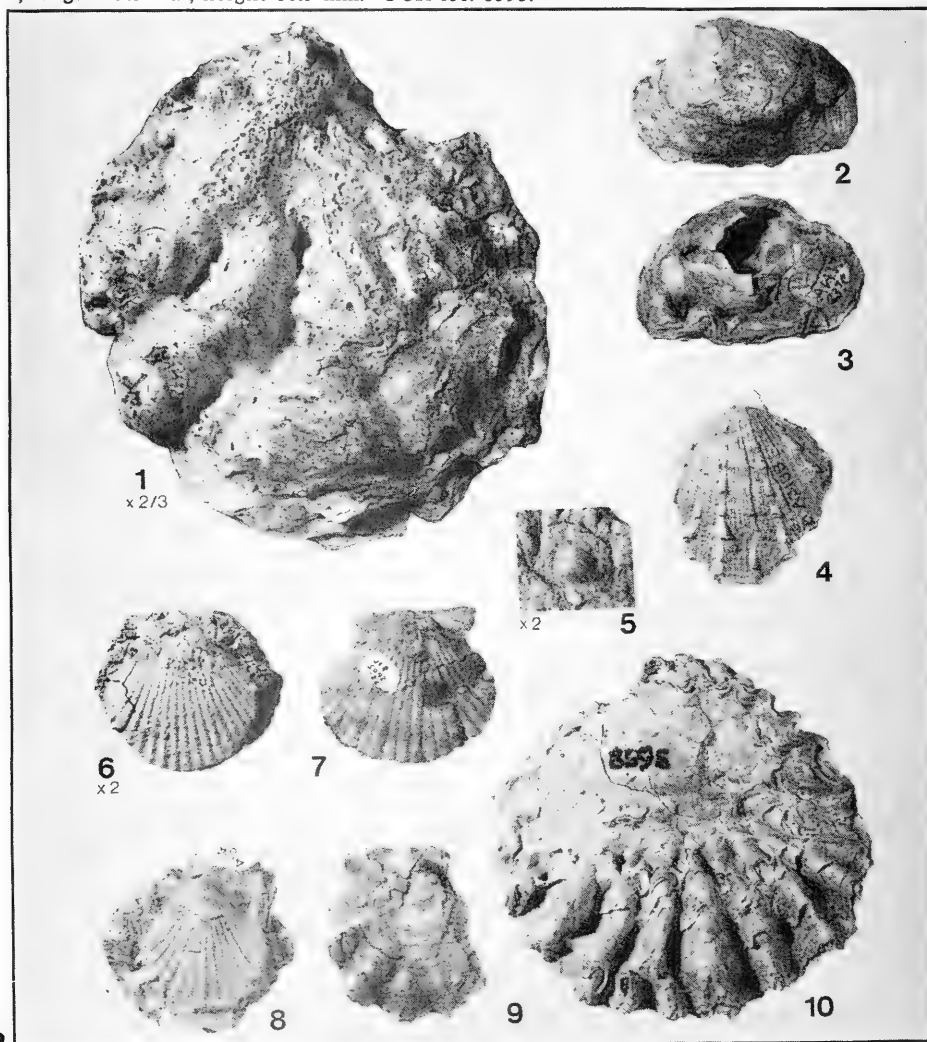


Figure 2. Stratigraphic relationships of the unnamed upper member and the Latrania Sand Member of the Imperial Formation, and their inferred depths of deposition along Super Creek, Riverside County, California.

PLATE 1 (All figures x1 except as indicated)

Figure 1. *Pycnodonte* (*Pycnodonte*?) *heermanni* (Conrad, 1855). Left valve. LACMIP 7162; length 131 mm, height 148 mm. sp. CIT loc. 192. Figures 2 and 3. *Anomia peruviana* d'Orbigny, 1846. Articulated valves. UCMP 37531; length 49.9 mm, height 35.1 mm. UCMP loc. A-1417. Figure 4. *Spondylus victoriae* Sowerby, 1859. Right valve. UCMP 37532; length 35.4 mm, height 39.6 mm. UCMP loc. A-3188. Figure 5. *Cyclopecten* sp. cf. *C. pernomus* (Hertlein, 1935). Right valve. UCMP 37533; length 4.4 mm, height 4.8 mm. UCMP loc. A-1407. Figure 6. *Argopecten* sp. cf. *A. mendenhalli* (Arnold, 1906). Left valve?. UCR 5035/11; length 17.1 mm, height 18.1 mm. UCR loc. 5035. Figure 7. *Argopecten sverdrupi* (Durham, 1950). Right valve. UCR 5042/23; length 39.1 mm, height 34.6 mm. UCR loc. 5042. Figure 8. *Leptopecten* (*Leptopecten*) *palmeri* (Dall, 1897). Left valve. UCR 4777/11; length 26.3 mm, height 27.6 mm. UCR loc. 4777. Figure 9. *Dendostrea? vespertina* (Conrad, 1854). Right valve. LACMIP 7163; length 31.1 mm, height 38.1 mm. CIT loc. 187. Figure 10. *Dendostrea angelica* (Rocheburne, 1895). Left valve. LACMIP 7164; length 79.5 mm, height 80.5 mm. UCR loc. 8595.



MINUTES
EXECUTIVE BOARD MEETING
Western Society of Malacologists
Santa Cruz, California

16 August 1984

Present: Coan, Hertz, Hochberg, Kennedy, Koch, Lindberg, Long, McLean, Mulliner, Pitt, Shasky, Skoglund. Guest: Lois Pitt

The meeting was called to order by President George Kennedy at 6:45pm.

Treasurer's Report: Margaret Mulliner presented the Treasurer's Report.

As of 1 September 1983 the Society treasury had a balance of \$4,566.86 (see attachment A).

MSP to accept Treasurer's Report as presented.

Secretary's Report: Eric Hochberg read the minutes from the 1983 meeting. There was a brief discussion concerning the amount allotted for the Annual Report.

1984-85 Officers: Chairman of the Nominating Committee, Dave Lindberg, presented the following slate of officers:

President:	William P. Pitt
1st Vice President	Carole M. Hertz
2nd Vice President	Matthew J. James
Secretary	F.G. Hochberg
Treasurer	Margaret Mulliner
Members-at-Large	Sally Bennett, Patrick I. LaFollette

MSP to accept slate of officers as presented.

1985 Annual Meeting: Bill Pitt reported that 1985 meeting will be held in August at the University of California, Santa Barbara. Confirmation of exact dates will not be available until November. All meetings, housing and meals will be in same building on campus. A minimum of 50 people are needed in dorms at a cost of about \$38/day. Pitt will oversee arrangements with Hochberg.

MSP to designate Santa Barbara as the site for the 1985 Annual Meeting.

Student Grant Committee: In the absence of Vida Kenk, there was general discussion on the concept of student grants vs. student paper awards.

The WSM student fund supports Student Research Grants that are awarded every other year. Skoglund indicated that the Southwestern Malacological Society wants to raise the amount of their financial support but not to exceed the WSM grant award. At present the monetary value of these grants is:

First Place Grant (WSM)	\$600
Second Place Grant (SWMS)	\$500

MS to raise Student Research Grant to \$750 for 1985-86, [plus any additional expenses].

Amended and accepted to strike words in brackets.

Motion PASSED as amended.

Budget: A discussion was initiated on the increased cost of the expanded Annual Report and whether we could or should support this increase. The 1983 report contained 56 pages and cost \$2200. One of the principal costs was the cost of type setting. At current prices the Annual Report costs \$6.57/copy and membership dues are \$7.50/person.

MSP to limit the Annual Report to a run of 250 copies, to six signatures (or 48 pages) and to a total cost not to exceed \$1800.

Lindberg indicated that the previous editor, Mike Kellogg, had programmed 1600 BPI magnetic tapes for the Annual Report. Why not retrieve these? Current editor, Steve Long, said that no information or tapes had been forwarded to him from the former editor.

President Kennedy thanked Steve Long for his fine job as editor and for using his bulk rate to mail out the Annual Report.

No expenses were incurred from the 1983 Seattle meeting, hence our budget is larger than normal.

Registration fees for the Annual Meeting are set by the President in response to the anticipated costs of the meeting. The income covers the expenses of conference room rental fees, projectors, coffee breaks, insurance and incidentals. Meetings are designed to break even. Hochberg stressed that it should be standard practice to prepare a post-meeting budget that details registration income and all meeting related expenses.

Advisory Board: Lindberg reported that, in order to form an Advisory Board the By-Laws must be changed. In order to change the By-Laws, the Society must be dissolved, Charter rewritten and a fee of \$1500 paid to reincorporate. In the context of the existing Charter and By-Laws the establishment of an Advisory Board is not feasible and it was informally decided to drop the proposal.

Lindberg indicated that he has a copy of an earlier draft of the Officer's Manual that includes all this information and will pass it on to Board members.

OTHER BUSINESS

1. Project Data Log: President Kennedy proposed a Data Log project to stimulate memberships and general interest in the Society. The first topic suggested would deal with spawning data. Kennedy indicated that several members had written to support the concept.

Skoglund indicated that there were problems in committing the Society's resources to such a project without prior approval of the Executive Board. A second problem concerns quality control and editing. Who will be responsible for verifying or reviewing spawning records and who will format and edit these data for publication?

Hertz recommended that Kennedy present a paper at the 1985 Annual Meeting on Project Data Log and summarize the spawning information received from members.

2. 1986 AMU Meeting: An invitation from James Nybakken to host a joint AMU/WSM meeting in Monterey in 1986 was received and tentatively rejected by Hertz. Skoglund pointed out that this is not an individual decision but needs to be a decision of the membership.

Considerable discussion was generated over the advantages and disadvantages of holding a joint meeting with AMU. There is a general feeling among many WSM members that AMU does not recognize the Society's contribution at joint meetings held on the west coast. It was stressed, however, that any move to hold separate meetings in 1986 might force people to

choose between the meetings. With a strong core of malacologists developing on the west coast, the WSM has the opportunity to work together with AMU for the common good.

3. Permanent Archive for WSM Records: Mulliner mentioned that we are accumulating historical documents and other materials that need to be archived. Records are kept for three years, though Mulliner recommended that the minimum period for storage be seven years.

MSP to direct the President and Secretary to investigate the possibility of establishing a permanent archive for WSM and to report on a potential location at the 1985 meeting.

4. Gratis Copies of the Annual Report: Mulliner stated that there are problems with the distribution of gratis copies of the Annual Report. At present 50 copies per year are sent out under an arrangement originally set up by Gene Coan. For the record, the Treasurer and Secretary need to know who gets copies and whether we are to receive anything in exchange. President Kennedy asked Coan to serve as a permanent reviewer for gratis copies. He further directed the Secretary to update the records for sending out a form letter to see if all recipients receive their copies, if they still want to continue to receive the Annual Report and how the publication is being used.

5. Back Issues of Annual Reports: Mulliner indicated that we have a large inventory of back issues of the Annual Report, which would be desirable to distribute. The current cost of a complete set of back issues is \$90.

The suggestion was made to sell off sets of back issues for \$45. This will be announced in the next Annual Report.

MSP to assemble a number of complete sets of back issues which will then be:

- presented to recipients of the Student Research Grant and to the recipient of the 1984 first place Student Paper Award
- sent to institutional libraries that do not have copies, as a public relations gesture from the Society
- sent to reprint dealers and book sellers
- sent out as incentive for joining the Society. Put note on membership application form to advertise availability for purchase.

Steve Long indicated an interest in purchasing sets of back issues. He will approach the President with a proposal that needs final approval by the Executive Board.

6. Telephone Numbers: President Kennedy suggested that phone numbers be published along with member addresses in the Annual Report, or at least be made available to WSM officers, for ease of contacting members of the Society. Hochberg stated that many people do not want their numbers listed for privacy reasons. This will be listed as optional on the membership application form.

7. Student Awards: The problem of Student Awards for best papers at the Annual Meeting was brought up. Kennedy advertised in meeting announcement flyer that three awards would be presented but money had not been allotted by Executive Board. Discussion deferred to new business.

MSP to present three awards for best student papers at the 1984 Annual Meeting.

The first place award will include a set of available back issues of the Annual Report. All three will be given WSM memberships for the year 1984-85.

MSP to authorize expenditure of award money for the 1984 meeting only:

1st place	\$100
2nd place	\$ 75
3rd place	\$ 50

President Kennedy will set up an awards committee to judge student papers during the meeting.

The money for the awards will be derived from sale of the shell cases.

8. Executive Board Meeting: Hochberg recommended that the Executive Board Meeting be held just before the Annual Meeting, in order to avoid conflicts with meeting events.
9. Membership Application Form: Secretary Hochberg will design a new membership application form which will be type set and printed with the WSM logo.
10. Editorial Board: President Kennedy appointed Steve Long as Editor for 1984 Annual Report. Kennedy will serve as technical editor.

President Kennedy appointed the Editorial Board which consists of the following members: Steve Long, Hans Bertsch, Gene Coan, George Kennedy and Barry Roth. The committee will review manuscripts for Annual Reports.

It was recommended that the Annual Report be open only to papers by members of the Society.

11. Historian: President Kennedy announced that Jody Woolsey volunteered to serve as Historian for the 1984 Annual Meeting.

There being no further business, the meeting was adjourned at 10:45pm.

Respectfully submitted _____

F.G. Hochberg
Secretary

Approved by _____

George L. Kennedy
President (1983-84)

MINUTES **ANNUAL BUSINESS MEETING** Western Society of Malacologists

18 AUGUST 1984

Present: 50 members

The meeting was called to order by President George Kennedy at 3:45pm.

Secretary's Report: Eric Hochberg read the minutes from the 1983 Annual Business Meeting.

MSP to approve the minutes as read.

Treasurer's Report: Margaret Mulliner presented the Treasurer's Report for the period 1 September

1983 to 15 August 1984 (see attached).

MSP to accept report as presented.

Committee Appointments: President Kennedy appointed the following committees:

Audit: Jules Hertz (Chairman), Carole Hertz, William Perrin

Parliamentarian: Eugene Coan

Student Grants: Vida Kenk (Chairman), Eugene Coan, James Nybakken, Barry Roth, Judy Terry-Smith

Student Awards (new): Judy Terry-Smith (Chairman)

Editor: Steve Long agreed to serve as the Editor for the 1984 Annual Report.

Abstracts are due by 31 August and should be submitted to President Kennedy.

Display Cases: Sealed bids for purchase of the old AMU-PD cases are to be submitted to Dave Lindberg. Sale will be to the highest bidder. WSM will not cover the cost of transportation.

Election of Officers: In the absence of Committee Chairman Lindberg, Carol Skoglund presented the following slate of officers for 1984-1985:

President	William D. Pitt
1st Vice President	Carole M. Hertz
2nd Vice President	Matthew J. James
Secretary	F.G. Hochberg
Treasurer	Margaret Mulliner
Members-at-Large	Sally Bennett, Patrick I. LaFollette

No additional nominations were submitted from the floor.

MSP to elect slate of officers as presented.

President Kennedy thanked the officers and all the people who helped to produce an excellent Annual Meeting. He then turned the meeting over to President-elect William Pitt. Pitt thanked Kennedy for his efforts as President during the year.

NEW BUSINESS

1. 1985 Annual Meeting: President Pitt announced that the 1985 Annual Meeting will be held in Santa Barbara on the campus of the University of California. The dates will be 18-21 August, 1985, pending final approval from the University.

Symposia arrangements were not complete. Information will be available when the meeting announcement and call for papers go out in March.

Field trips will be arranged by the Santa Barbara Museum of Natural History. The members expressed interest in diving, dredging, intertidal, fossil and island trips.

2. Project Data Log: George Kennedy will organize a session on Project Data Log for the 1985 meeting. Members expressing an interest in the project will be sent a datasheet that Kennedy will prepare. The topic proposed for 1985 is a compilation of spawning data for marine mollusks. The information received will be compiled by Kennedy for general distribution. All persons submitting data will be required to provide documentation (e.g., slides, specimens) to verify identification of spawning organisms.

3. Student Research Grant: Secretary Hochberg presented the Executive Board's recommendation to raise the amount of the WSM Student Research Grant.

MSP to provide \$750 for the 1985 WSM Student Research Grant.

4. Auction: Carole Hertz reported that the proceeds from the Auction were \$975. She thanked all donors and others who helped with the Auction.

President Pitt asked if members would be interested in having fossils added to the auction. No one expressed any interest and the matter was dropped.

5. 1986 AMU Meeting: President Pitt announced that the WSM had received an invitation from James Nybakken to join the AMU for a joint meeting in Monterey in 1986. Considerable discussion ensued. As spokesman for the professional malacologists Michael Ghiselin supported the concept of a joint meeting. The west coast currently has an active malacology community with some fine young professionals and a number of aspiring students. An impressive showing by the WSM will demonstrate the vitality of our west coast organization. If two meetings are held many professionals and students may be forced to make a choice, which will likely affect the WSM.

Concerns were expressed that the WSM will be treated as an equal at the meeting and that WSM be given equal billing in the announcement of the meeting. A second problem seems to be that the meeting may be held in an expensive hotel in the Monterey area. These concerns will be addressed as plans are made for the 1986 meeting.

MSP to meet jointly with the AMU in Monterey in 1986.

Jules Hertz stressed that it will be important to appoint a committee to work out joint arrangements with AMU for the 1986 meeting.

President Pitt appointed an ad hoc committee for this purpose consisting of:
Barry Roth (Chairman)
F.G. Hochberg

They are to report on arrangements at the next Annual Meeting.

6. There being no further business, President Pitt adjourned the meeting at 4:38pm.

Respectfully submitted _____

F.G. Hochberg
Secretary

Approved by _____

George L. Kennedy
President (1983-1984)

TREASURER'S REPORT

Period covering 9/1/1983 to 10/31/1984

Balance begining of period \$4566.86

INCOME

Dues	1983	Regular	26 - 7.50ea	195.00		
		Family	4 - 1.00ea	4.00	199.00	
	1984	Regular	185 - 7.50ea	1387.50		
		Family	28 - 1.00ea	28.00		
		Student	14 - 3.00ea	42.00	1457.50	
	1985	Regular	3 - 7.50ea	22.50	22.50	\$1679.00

PUBLICATIONS

2 Vol. - 7.50ea	15.00	15.00
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DONATIONS

Student Fund	253.50	253.50
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INTEREST On SAVINGS ACCOUNT

242.66	242.66
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AUCTION

994.90	994.90
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PRE-REGISTRATION FEES

8153.89	8153.89	\$9659.95

		Income \$15905.81
		Expenses \$10831.44

		Balance \$5074.37

PERIOD COVERING 9/1/1983 to 10/31/84

EXPENSES

Treasurer	357.34
President	268.70*
Secretary of State	2.50
COA dues	7.50
AMU dues	22.50
Conference fees	
UC Regents	7395.68
Pre-Registration Refunds	108.00
	25.00
	42.00
	5.00
Refreshments for Conference	43.10
Student Awards	100.00
	75.00
	50.00*
Auction (refund for overcharge)	3.00
Annual Report (340 copies)	
Typesetting	1085.50
Printing	825.00
Corrections	235.00
Postage	89.28
	2234.78
Editor (Misc. Costs)	91.84
	Total \$10831.44

*Checks outstanding 10/31/84

Student Award	50.00
President	220.00

	270.00

Margaret Mulliner, Treasurer

Auditing Committee

Eugene V. Coan

James Nybakken

Barry Roth

Executive Board and Committee Members 1984-1985

OFFICERS & EXECUTIVE BOARD

	1983-84	1984-85
President	George L. Kennedy	William D. Pitt
1st Vice President	William D. Pitt	Carole Hertz
2nd Vice President	Carole M. Hertz	Terrence M. Gosliner
Secretary	F.G. Hochberg	F. G. Hochberg
Treasurer	Margaret Mulliner	Margaret Mulliner
Members-at-Large	Joyce Gemmell	Sally Bennett
	Robert Koch	Patrick I. LaFollette
Three most recent past Presidents	David R. Lindberg	George L. Kennedy
	Donald R. Shasky	David R. Lindberg
	Carol C. Skoglund	Donald R. Shasky
Mentor-Parliamentarian	Eugene V. Coan	

STANDING COMMITTEES

Editorial Board	Steven J. Long, Editor	Steven J. Long, Editor
	Hans Bertsch	Hans Bertsch
	Eugene V. Coan	Eugene V. Coan
	George L. Kennedy	George L. Kennedy
		Barry Roth
Auditing*	Eugen V. Coan*	Jules Hertz*
	James W. Nybakken	Carole M. Hertz
	Barry Roth	William Perrin
Nominating	David R. Lindberg*	George L. Kennedy*
	Donald R. Shasky	David R. Lindberg
	Carol C. Skoglund	Donald R. Shasky
Student Grants	Vida C. Kenk*	
	Eugene V. Coan, James W. Nybakken	
	Barry Roth, Judith Terry Smith	
Student Awards	Judith Terry Smith	

1984 MEETING COMMITTEES and APPOINTMENTS

University Liason	John S. Pearse
University Conference Coordinator	Jane D. Fisher
Conference Chairman	George L. Kennedy
Registration	Margaret Mulliner*, Barbara Farmer
Hospitality	Rose Marie Kennedy
Session Chairpersons	Hans Bertsch
	Terrence M. Gosliner
	F.G. Hochberg
	George L. Kennedy
	Barry Roth
Audio-visual	Kathleen M. Langan, Paul H. Scott
Auction	Carole M. Hertz & William D. Pitt, Co-auctioneers
	Sally Bennett, Rose Marie Kennedy
Banquet Speaker	Steven K. Webster
Historian	Jody Woolsey

*(indicates chairperson)

Group Photograph



Western Society of Malacologists Annual Report
August, 1985 - Volume 17 for 1984

List of People in Group Photo

Front Row (left to right): Kate St. Jean, Edna Naranjo, Edith Abbott, Marjorie Wing, Claire Fahy, Neil Fahy, Bert Draper.

2nd Row: Kit Stewart, May W. Yipp, Jo Ramsaran, Marilyn Perrin, Sandy Gardner, Eve Shipp, Margaret Mulliner, Walter Carr, Barbara Farmer, Wesley M. Farmer, Forrest Poorman.

3rd Row: Jim McLeary, George Metz, Bill Perrin, Lois Pitt, Bill Pitt, Helen DuShane, Charlotte Norrid, Hal Norrid, Gene Everson, Cheryl Niemi, Timothy Pearce, Don Shasky, Ron Velarde.

4th Row: Gladys Weber, Bill Emerson, Terry Gosliner, Luis Aguilar, Wendy M. Koch, June King, Patrick I. LaFollette, William Keeler, Carol Skoglund, Paul Skoglund, Bruce Fowler.

5th Row: Steven Long, David Dudgeon, Tom Spight, Paul Scott, Doug Eernisse, Carole Hertz, Paul Dunn, Bob Koch, Roy Poorman, George Kennedy.

Back Row: Sally Bennett, Robert King, Michael Ghiselin, Jack Tomlinson, Jules Hertz, Hans Bertsch, Kirstie Kaiser, Sandra Millen, Roland Anderson, Clif Coney, Jeff Goddard, Eric Hochberg, Alan Hebert.

Western Shell Clubs

Chico Seashell Club

c/o Phyllis Slattery, Sec.
106 Terrace Drive
Chico, CA 95926

[meets twice a month, 2nd Wed. 9:30 am in member's homes, and 4th Wed. 7:30 pm at Pleasant Valley Recreation Center, North Avenue, Chico, CA]

Conchological Club of Southern California

c/o Malacology Section
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, CA 90007

[meets in Museum Lounge, 7:30 pm, first Monday of each month, unless a holiday, then on Wednesday of same week]

Hawaiian Malacological Society

P.O. Box 10391
Honolulu, HI 96816

[meets first Wednesday of each month, 7:00 pm, at First United Methodist Church, Victoria & Beretania Streets, Honolulu; December party at another location]

Houston Conchological Society

c/o Constance Boone
3706 Rice Boulevard
Houston, TX 77005

[meets fourth Wednesday of August, September, October, January, February, March, April, and May; third Wednesday of November, at the Houston Museum of Natural Science]

Monterey Peninsula Shell Club

Donna Fagan, secretary
4158 El Bosque Drive
Pebble Beach, CA 93953

[meets at the Allen Knight Maritime Museum, 550 Calle Principal, Monterey, California, on the third Tuesday of each month at 7:30 pm. Programs and local collecting trips are planned monthly]

Northern California Malacozoological Club

121 Wild Horse Valley Drive
Novato, CA 94947

[meets third Thursday of each month at the California Academy of Sciences]

Oregon Society of Conchologists

Dr. Byron W. Travis
4324 NE 47th Avenue
Portland, OR 97218

[meets first Sunday of each month, 1:30 pm, in private homes; announcements given in monthly paper or by card]

Pacific Northwest Shell Club, Inc.

c/o 15128 Sunwood Blvd.
Tukwila, WA 98188

Pacific Shell Club

c/o John Boyd
11813 Morning Ave.
Downey, CA 90241

[meets in Museum Lounge first Sunday of each month, 1:30 pm, October through June]

San Diego Shell Club

c/o 3883 Mt. Blackburn Avenue
San Diego, CA 92111

[meets third Thursday of every month, Casa del Prado, Balboa Park]

Santa Barbara Malacological Society

P.O. Box 30191
Santa Barbara, CA 93105

[meets third Friday of every month, 7:30 pm, Santa Barbara Museum of Natural History, 2559 Puesta del Sol]

Southwestern Malacological Society

c/o Mrs. Carol C. Skoglund
3846 E. Highland Avenue
Phoenix, AZ 85015

[meets third Wednesdays, September through May, 7:30 pm, Asbury United Methodist Church, 1601 W. Indian School Road, in auxiliary rooms]

Yucaipa Shell Club

c/o Mousley Museum of Natural History
35308 Panorama Drive
Yucaipa, CA 92399

[meets third Sunday of every month except August, 2:00 pm, in the museum]

Membership Directory

- Abbott, Dr. R. Tucker, P.O. Box 2255, Melbourne, FL 32902-2255
 Abbott, Mrs. Keith (Edith M.), 1264 W. Cienega Avenue, San Dimas, CA 91773
 Academy of Natural Sciences, The Library, Nineteenth & The Parkway, Philadelphia, PA 19103
 Adams, Mr. Elmo W., 747 Winchester Drive, Burlingame, CA 94010
 Adams, Ms. Catherine R., 3414 Arlington Blvd., Arlington, VA 22204
 Alan Hancock Foundation, Hancock Library, University of Southern California, University Park, Los Angeles, CA 90007
 American Geological Institute, The Library, 4220 King St., Alexandria, VA 22302
 American Malacological Union, Inc., 7602 McCullough Avenue, San Antonio, TX 78216
 American Museum of Natural History, Serials Unit, Library, Central Park West at 79th Street, New York, NY 10024
 Anderson, Roland, Seattle Aquarium, Pier 59, Seattle, WA 98101
 Arizona State University, The Library, Department of Zoology, Tempe, AZ 85281
 Ashbough, Karen, 9045 Comet Street, El Paso, TX 79904
 Australian Museum, The Library, Box A285, Sydney, South, N.S.W., Australia 2000
 Aviles, E., Prof. Miguel C., Apartado 6-765, Zona Postal el Dorado, Panama
 Ayala, Sr. Ramon Enrique, Apdo 6-7628 El Dorado, Panama
 Baerreis, David A., P.O. Box 4651, Taos, NM 87571
 Baskevitch, Mr. Eugene, 527 N Plymouth Boulevard, Los Angeles, CA 90004
 Baxter, Mr. Rae, Alaska Department of Fish & Game, P.O. Box 96, Bethel, AK 99559
 Bennett, Sally, 1701 Hyland St., Bayside, CA 95524
 Bergland, Mr. Con, P.O. Box 173, Bouse, AZ 85325
 Bernice P. Bishop Museum, The Library, P.O. Box 19000-A, Honolulu, HI 96817
 Bertsch, Dr. Hans W., 4444 W. Pt. Loma Blvd. #83, San Diego, CA 92107
 Biosciences Information Service, Literature Resources Department, 2100 Arch Street, Philadelphia, PA 19103
 Body, Mr. Ralph L., 2538 10th Avenue West, Seattle, WA 98119
 Boone, Mrs. Hollis Q. (Constance), 3706 Rice Boulevard, Houston, TX 77005
 Borrero, Sr. Francisco, c/o Dr. David L. Claybrook, Department of Biology, University of South Carolina, Columbia, SC 29208
 Boss, Dr. Kenneth J., Professor of Biology, Dept. of Mollusks, Museum of Comparative Zoology, Harvard University, 26 Oxford St., Cambridge, MA 02138
 Bradner, Hugh & Marge, 1867 Caminito Marzella, La Jolla, CA 92037
 Bratcher, Mrs. Ford (Twila), 8121 Mulholland Terrace, Hollywood, CA 90046
 Breitgam, Rev. Richard, 420 Alameda Padre Serra, Santa Barbara, CA 93103
 British Library, Accessions Department, Lending Division, Boston Spa, Wetherby, Yorkshire, LS23 7BQ, England
 British Museum (Natural History), Zoology Library, Cromwell Road, London, SW7 5BD, England
 Brookshire, Mr. Jack W., 2962 Balboa Avenue, Oxnard, CA 93030
 Burch, Beatrice L., 236 Kuuhua Place, P.O. Box 309, Kailua, Oahu, HI 96734
 Burch, Dr. Thomas A., P.O. Box 309, Kailua, Oahu, HI 96734
 California Academy of Sciences, The Library, Golden Gate Park, San Francisco, CA 94118
 California Institute of Technology, Millikan Library, Acquisitions 1-32, 1201 E. California Boulevard, Pasadena, CA 91109
 Carlton, Dr. James T., Williams College - Mystic Seaport, Maritime Studies, Mystic Seaport Museum, Mystic, CT 06355
 Carnegie Museum of Natural History, The Library, 4400 Forbes Avenue, Pittsburgh, PA 15213
 Carr, Walter E. Jr., M.D., 2043 Mohawk Drive, Pleasant Hill, CA 94523
 Cate, Mrs. Jean M., P.O. Box 3049, Rancho Santa Fe, CA 92067
 Centro de Ciencias del Mar y Limnología, Biblioteca, AP Postal 70-305, Ciudad Universitaria, Mexico 20, D.F., Mexico
 Chaney, Mrs. Barbara K. & Dr. Henry W., 1633 Posilipo Lane, Santa Barbara, CA 93108
 Chico Sea Shell Club, 106 Terrace Drive, Chico, CA 95926
 Clover, Mr. Phillip W., P.O. Box 339, Glen Ellen, CA 95442
 Coan, Dr. Eugene V., 891 San Jude Ave., Palo Alto, CA 94306
 Conchologists of America, Clair F. Stahl, Treasurer, 3235 NE 61st Avenue, Portland, OR 97213
 Connor, Valerie, E.P.A., Marine Science Center, Newport, OR 97365
 Corner, Ms. Barbara D., 1231 Londonderry Lane, Ocean Springs, MS 39564
 Covey, Jewell M., 5666 E. Hampton, Apt. 252, Tucson, AZ 85712
 Cox, Keith W. (JC), Muscat (ID), Department of State, Washington, DC 20520
 Crane, Mr. Phillip C., Box 66, San Gregorio, CA 94074
 D'Attilio, Mr. Anthony, Natural History Museum, Department of Invertebrate Zoology, P.O. Box 1390, San Diego, CA 92112
 Deisler, Jane E., Dept. of Ecol. & Evol. Biol., University of Arizona, Tucson, AZ 85721
 DeMartini, Dr. John D., 1111 Birch Avenue, McKinleyville, CA 95521
 Demond, Ms. Joan, 202 Bicknell Avenue, #8, Santa Monica, CA 90405
 DiIworth, Mrs. Billee, 6333 La Jolla Boulevard, #171, La Jolla, CA 92037
 Draper, Mr. Bertram C., 8511 Blieriot Avenue, Los Angeles, CA 90045
 DuShane, Mrs. Joseph (Helen), 15012 El Soneto Drive, Whittier, CA 90605
 Dundee, Dr. Dolores S. (Dee), Department of Biological Sciences, University of New Orleans - Lakefront, New Orleans, LA 70148
 Ebenstein, Mr. David D., University of Southern California, Department of Biological Sciences, University Park, Los Angeles, CA 90089-0371
 Eernisse, Dr. Douglas J., Friday Harbor Laboratories, Friday Harbor, WA 98250
 Emerson, Dr. William K., Department of Living & Fossil Invertebrates, American Museum of Natural History, Central Park West at 79th Street, New York, NY 10024
 Eng, Dr. Larry L., California Department of Fish & Game, Planning Branch, 1416 Ninth Street, Sacramento, CA 95814
 Eutenier, Mr. Mark Seth, 3859 Polton Place Way, San Jose, CA 95121
 Everson, Mr. Gene D., 5703 Court View Dr., Charlotte, NC 28226
 Fahy, Neil E. & Claire L., 1425 Mayfair Ave., Daly City, CA 94015
 Farmer, Dr. Wesley M. & Barbara, 11061 Lea Terrace Drive, Santee, CA 92071
 Ferguson, Mr. Ralph E., 617 N Fires Avenue, Wilmington, CA 90744

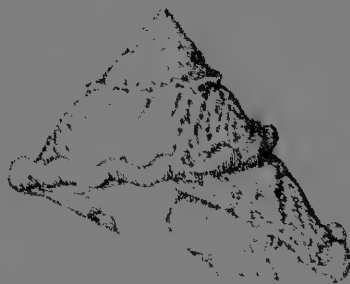
Ferreira, Dr. Antonio J., 2060 Clamar Way, San Jose, CA 95128
 Field Museum of Natural History, Library - Serials, Roosevelt Road at Lake Shore Drive, Chicago, IL 60605-2498
 Fisheries Canada, Pacific Biological Station, Nanaimo, British Columbia, Canada V9R 5K6
 Fowler, Mr. Bruce H., 5512 Blossom Terrace Court, San Jose, CA 95124
 Friday Harbor Laboratory, The Library, Friday Harbor, WA 98250
 Gardner, Ms. Sandra M. (Sandy), 1755 University Avenue, Palo Alto, CA 94301
 Geological Survey of Canada, Library - Room 350, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8
 Ghiselin, Dr. Michael T., Department of Invertebrate Zoology, California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118
 Good, Barbara, 1802 McKee Street #C-6, San Diego, CA 92110
 Goodrich, Mr. & Mrs. Wesley (Betty), P.O. Box 10952, Eugene, OR 97440
 Gosliner, Dr. Terrence M., Department of Invertebrate Zoology, California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118
 Habe, Tadashige, Section of Malacology, National Science Museum, 3-23-1, Hyakunincho, Shinjuku-ku, Tokyo, Japan 160
 Haigh, Mr. Ernest S. & Betty, 2465 Moraga Court, Simi Valley, CA 93065
 Harris, Dr. Larry G., Zoology Department, University of New Hampshire, Durham, NH 03824
 Harry, Dr. Harold W., 4612 Evergreen Street, Bellaire, TX 77401
 Hebert, Mr. Alan C., 124 Buckthorn Way #7, Menlo Park, CA 94025
 Hensill, Dr. John S., 2 W Summit Drive, Redwood City, CA 94062
 Hertz, Mr. & Mrs. Jules (Carole), 3883 Mt. Blackburn Ave., San Diego, CA 92111
 Hickman, Dr. Carole S., Department of Paleontology, University of California, Berkeley, CA 94720
 Hochberg, Dr. Fred G., Department of Invertebrate Zoology, Museum of Natural History, 2559 Puesta del Sol Road, Santa Barbara, CA 93105
 Hoffman, James E., Department of Ecology & Evol. Biology, University of Arizona, Tucson, AZ 85721
 Holiman, Mr. & Mrs. H. Wayne (Audrey B.), P.O. Box 246, Edinburg, TX 78540
 Hopkins Marine Station, The Library, Stanford University, Pacific Grove, CA 93950
 Hopper, Dr. Carol N. (Brill), 943C 9th Avenue, Honolulu, HI 96816
 Hunt, Harold G., 10318 Doyle Way, Rancho Cordova, CA 95670
 Institut Royal des Sciences Naturelles, de Belgique, Rue Vautier 31, 1040 Bruxelles, Belgium
 Institute of Geology and Paleontology, Library, Faculty of Science, Tohoku University, Sendai, Japan
 Israel Malacological Society, c/o Dr. H.K. Mienis, Department of Zoology, Hebrew University of Jerusalem, Jerusalem, Israel
 Jaekle, William, Dept. of Biological Sciences, University of Southern California, University Park, Los Angeles, CA 90089-0371
 James, Matthew J., Department of Paleontology, University of California, Berkeley, CA 94720
 Joffe, Anne, 1163 Kittiwake Circle, Sanibel Island, FL 33957
 Judge, Michael L., Graduate Group in Ecology, D.E.S., Wickson Hall, University of California, Davis, CA 95616
 Kaiser, Kirstie L., 786 Starlight Heights Dr., La Canada, CA 91011
 Keeler, Mr. William R., 105 Sonia Street, Oakland, CA 94618
 Keen, Dr. A. Myra, Friends House #6, 684 Benicia Dr., Santa Rosa, CA 95405
 Kenk, Dr. Vida C., 18596 Paseo Pueblo, Saratoga, CA 95070
 Kennedy, Dr. George L., Section of Invertebrate Paleontology, Los Angeles County Museum of Natural History, 900 Exposition Blvd., Los Angeles, CA 90007
 Kessner, Mr. Vince, c/o Department of Health, P.O. Box 40596, Darwin, N.T., 5792, Australia
 Kitting, Dr. Christopher L., University of Texas at Austin, Marine Sciences Institute, Port Aransas, TX 78373
 Knight, Ms. Lori B., Rt. 2, Box 112, Caldwell, ID 83605
 Koch, Robert & Wendy, 7227 N 15th Ave., Phoenix, AZ 85021
 LaFollette, Patrick Ives, Malacology Section, Los Angeles County Museum of Natural History, 900 Exposition Boulevard, Los Angeles, CA 90007
 Lance, James R., 746 Agate Street, San Diego, CA 92109
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THE WESTERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT



Santa Barbara, California
18-21 August, 1985

Volume 18

The Western Society of Malacologists

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Editorial Board, 1985-1986

Steven J. Long, Editor
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Eugene V. Coan
Terrence Gosliner
George L. Kennedy
Barry R. Roth

The **Annual Report** of the Western Society of Malacologists is based on its yearly meeting. Distribution of the **Annual Report** is free to regular and student members who are, at the time of issue, in good standing. Membership dues are \$7.50 and \$3.00 for students. Others of a regular member's family may join for an additional \$1.00; each family receives only one **Annual Report**.

The Western Society of Malacologists has issued two **Occasional Papers** -- No. 1, "Sea Shells of Tropical West America: Additions and Corrections to 1975" by Myra Keen & Eugene Coan; and No. 2, "A Catalogue of Collations of Works of Malacological Importance" by George E. Radwin & Eugene Coan. Each is priced at \$3.50. Both are still available.

Correspondence regarding membership and orders for additional or back issues of the **Annual Report** or the **Occasional Papers** should be addressed to the current W.S.M. Treasurer, Mrs. Margaret Mulliner, 5283 Vickie Drive, San Diego, CA 92109.

When full-length papers are included in the **Annual Report** or **Occasional Papers** they are reviewed by two members of the Editorial Board in addition to the Editor.

Notice of the 18th Annual Meeting
The Western Society of Malacologists in 1986.

The 19th Annual Meeting of the Western Society of Malacologists will be held jointly with the American Malacological Union. The meetings will be held in Monterey, California on July 1-6, 1986. In addition to the regular program of contributed papers, several symposia are planned. The meeting will also feature slide shows, exhibits, a shell and book auction, and field trips. All persons interested in west American mollusks should plan to attend this meeting. For further information, please contact WSM Secretary: Dr. F.G. Hochberg, Department of Invertebrate Zoology, Museum of Natural History, 2559 Puesta del Sol Road, Santa Barbara, CA 93105.

In Memoriam

The Western Society of Malacologists regrets deeply the loss of several of its long-time members during recent months. Their contributions to the Society and to malacology in general will be sorely missed. We extend our sympathy to their families and friends.

DOLORES S. DUNDEE
FRANK GOODE
A. MYRA KEEN
TED PHILLIPS
RUTH & BEN PURDY
JOSEPH ROSEWATER
RAYMOND UPTON

STUDENT GRANT AWARDS

WSM Student Grant: Mr. Kenneth J. Lohmann, Department of Zoology, University of Washington, Seattle, WA 98195. Title of Research Project: Geomagnetic Orientation by a Marine Mollusk.

Southwestern Malacological Society Student Grant: Ms. Janice L. Bell, Pacific Biomedical Research Center, University of Hawaii, 41 Abui St., Honolulu, HI 96813. Title of Research Project: Feeding and Growth of Gastropod Larvae.

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Short Program

Sunday, August 18

Registration

WSM Executive Board Meeting

Greetings, Opening Remarks, William Pitt, President

Contributed Papers: Matthew J. James, Chairperson

Wine and Cheese

Open House at Santa Barbara Museum of Natural History

Monday, August 19

Contributed Papers: Henry W. Chaney, Chairperson

Contributed papers with emphasis on Paleontology: Lou Ella Saul, Chairperson.

Symposium on Hawaiian Mollusks: Beatrice Burch, Chairperson

Auction

Tuesday, 20 August

Symposium on Hawaiian Mollusks, continued

Contributed Papers: Donald R. Shasky, Chairperson

Contributed Papers with an emphasis on Land Snails: Barry Roth, Chairperson.

Business Meeting

Banquet

Banquet Speaker, Mr Bob Hansen of The Nature Conservancy "Santa Cruz Island Today"

Wednesday, August 21

Field Trips

ABSTRACTS

Care and Feeding of the Captive Geoduck

[Abstract]

Roland Anderson
The Seattle Aquarium
Pier 59
Seattle, Washington 98101

The average lifespan of geoducks, *Panope generosa*, at the Seattle Aquarium has been short. Death was attributed to poor collecting techniques, malnutrition, injuries, and display techniques. Methods of increasing longevity were tested. Improved collecting techniques, dietary supplements, and antibiotic baths had a beneficial effect on survival.

* * * * *

**Resistance to Predation of a Clam
Humilaria kennerleyi (Reeve, 1863)**

[Abstract]

Roland Anderson
The Seattle Aquarium
Pier 59
Seattle, Washington 98

Humilaria kennerleyi (Kennerley's Venus) was found to be quite resistant to sea star predation and highly resistant to gastropod and cephalopod predation. Its prey resistance was attributed to the shape and thickness of its shell.

* * * * *

**Effects of Trematode Parasites on Laboratory Populations
of the Snail, Biomphalaria glabrata**

[Abstract]

Carolyn Ashbaugh
Department Biological Sciences
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Santa Barbara, California 93106

The number of *Biomphalaria glabrata* recruit snails which reached reproductive size by week 7 was significantly greater in the laboratory populations exposed weekly to *Schistosoma mansoni* miracidia than in control populations and populations exposed only once to *S. mansoni*. By week 7, the number of surviving members of the initial cohorts

differed significantly; no mortality occurred among the initial cohorts of the control during the entire ten week experiment.

The population structure and total snail density differed significantly in the weekly exposure populations from the control and single exposure populations.

Recently, a life history response to parasite pressure has been suggested (Smith-Trail, 1980; Minchella and Loverde, 1981; Minchella and Loverde, 1983; Minchella, 1985). The results of my experiment suggest that the first reproduction age, an important population parameter in this opportunistic species, was earliest for recruit snails in populations subjected to repeated parasite pressure.

* * * * *

Feeding and Reproductive Biology of Panamic Mollusks

[Abstract]

Hans Bertsch

National University
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The food items or egg masses of 25 gastropod species (6 prosobranch and 19 opisthobranch) occurring within the Gulf of California (from Bahia de los Angeles, Baja California, to Cabo San Lucas, Baja California Sur), Mexico, were illustrated with *in situ* underwater photographs. These visual data of molluscan evolutionary ecology included the prey of *Epitonium billeanum* (DuShane & Bratcher, 1965); *Cyphoma emarginatum* (Sowerby, 1830); *Simnia* spp.; *Chromodoris norrisi* Farmer, 1963; *Tritonia pickensi* Marcus & Marcus, 1967; *Lomanotus stauberi* Clark & Goetzfried, 1976; *Histiomena convovula* (Lance, 1962); and unnamed species of dorid and dendronotid nudibranchs. Egg masses of various chromodorid, dendronotid and eolid nudibranchs (including 4 unnamed species); the sacoglossan *Tridachiella diomedea* (Bergh, 1894); and the prosobranchs *Epitonium billeanum*, *Jenneria pustulata* (Lightfoot, 1786), and *Mitra sphoni* Shasky & Campbell, 1964, were illustrated.

Field work was supported by grants from the George Lindsay Fund for Field Research (California Academy of Sciences, to Drs. Gosliner, Ghiselin and Lee) and by grants from and with the help of participants on my Have Mule Will Travel research expeditions to Isla Cerralvo and Punta Las Arenas (especially E. Lenard, T. Smith, P. Dougherty, M. Kelley and S. Kelley).

* * * * *

Terebridae of Hawaii

[Abstract]

Twila Bratcher

8121 Mulholland Terrace
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Forty-seven species of terebrids are found in Hawaii, 10 *Hastula*, 34 *Terebra*, two *Duplicaria*, and one *Terenolla*. The following appear to be endemic: *Terebra achates* Weaver, 1960, *T. nodularis* Deshayes, 1859, *T. rosacea* Pease, 1869, *T. waikikiensis* Pilsbry, 1921, *Hastula inconstans* (Hinds, 1844), *Duplicaria gouldi* (Deshayes, 1859), and *D. thaani* (Pilsbry, 1921). The following species were omitted from Dr. Alison Kay's book, **Hawaiian Marine Shells**, or were not figured: *Terebra amoena*, Deshayes, 1859, *T. elliscrossi* Bratcher, 1979, *T. virgo* Schepman, 1913, *Hastula acumen* (Deshayes, 1859), and *H. philippiana* (Deshayes, 1859).

Predation by Naticidae after a Devastating Storm in Pinna Beds off Waikiki, Oahu, Hawaii 1980

[Abstract]

Beatrice L. Burch
Research Associate in Zoology
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and

Thomas A. Burch
Kailua, Hawaii

There were great increases in the numbers of families, species and specimens of small sized mollusks found in the biogenetic sediments of the coral reef front off Waikiki, Oahu, following the storm of January, 1980, which destroyed the large beds of *Pinna muricata* Linnaeus, 1758. Species of *Terebra* form the most abundant molluscan fauna found alive currently at the depths of 32-80m.

The most visible predator was *Natica gualteriana* Recluz, 1844, which has increased by a factor of 45 after the storm. However, the proportion of preyed-upon Mollusca did not change significantly even though the number of both predator and prey increased dramatically. The most common prey of *Natica gualteriana* both before and after the storm was *Natica gualteriana* itself.

* * * * *

It's easy to say Crepidula!

[Abstract]

Jean M. Cate (read by Hans Bertsch)
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This is a short paper summarizing a forthcoming book by Jean Cate and Selma Raskin, primarily on the pronunciation of the scientific names of sea shells. The book also contains a 12-page glossary of malacological terms and an index of common names. The latter is cross-referenced with the scientific name index, to help one find a scientific name if only the common name is known. It will have some illustrations, a brief discussion of the formation of patronymic names, a bibliography and other useful aids for conchologists and malacologists. It will be useful for beginners as well as the more advanced.

Conus ximenes and Conus mahogani: a comparative study
[Abstract]

Henry W. Chaney
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Shell morphology, radulae and anatomy of both *Conus ximenes* and *C. mahogani* were studied and compared from populations collected from the same locality in Baja California. Although very closely related, these specimens differ in enough aspects to warrant a re-evaluation of the current view that *C. mahogani* is only a variant of *C. ximenes* and not a distinct species.

* * * * *

**The Malacological Contributions
of Josiah Keep and Henry Hemphill**
[Extended Abstract]

Gene Coan
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Josiah Keep was an early malacologist on the West Coast whose particular contribution was as a popularizer. The several editions of his *West Coast Shells* were responsible for recruiting the interest of many a student and amateur.

He was born in Paxton, Massachusetts, on May 11, 1849. He received a Bachelor's degree from Amherst College in 1874 and a Master's from the same institution in 1877. That year he also married and moved to California. There he taught at the Golden Gate Academy for one year, then Alameda High School for seven years, where he was principal from 1881 to 1885.

Then he became Professor of Natural Sciences at Mills College in Oakland, California, with which he was associated for the rest of his life. He came to specialize in courses in geology and astronomy, but his real love was the Mollusca. Between 1881 and 1910 he published several editions of a handbook on the shells of the West Coast, and the interest they elicited was one of the cornerstones of malacology in the western states.

He died in Pacific Grove, California, on July 27, 1911, where he is buried.

I have in press a complete bibliography of Keep's papers on the Mollusca. Careful examination of the 1887 edition of *West Coast Shells* reveals that he inadvertently introduced and made available 12 Carpenter and Hemphill manuscript names.

Keep's personal collection was sold by his family in 1915 to the Institute of Geology & Paleontology of Tohoku University in Sendai, Japan, where it is housed today. The larger portion of the separate, Mills College Collection went to the Department of Paleontology at the University of California at Berkeley. A smaller part went to the Department of Invertebrate Zoology at the California Academy of Sciences.

Henry Hemphill was an early and influential malacologist on the West Coast. He amassed a huge collection of land, fresh-water, and marine mollusks, which, when divided, became the nucleus of the present holdings of the California Academy of Sciences and Stanford University.

An article that Barry Roth and I have prepared provides a complete bibliography of Hemphill's published works on mollusks and lists the nomenclatural units that were first published by him, or that have been credited to him.

He was born in Delaware in 1830. Beginning around 1861, he traveled in the West, finally settling in San Diego, California, in 1865, where he worked as a bricklayer. However, he also made a number of gold prospecting trips in the western states. He evidently started collecting mollusks as early as 1861 and increasingly turned his attention from gold to mollusks. He collected extensively throughout the western states, Baja California, and Florida.

From the 1870s to 1890 he published small catalogs of shells for sale, as well as articles in the *Proceedings of the California Academy of Sciences*, *The Nautilus*, and other serials.

Around 1909, he moved to Oakland, California, to live with his daughter. He died July 24, 1914, as a result of contact with arsenic he used in preserving specimens.

Some of Hemphill's practices have caused problems for later systematists. He sorted his material for uniformity, thereby destroying all evidence of population structure and lumped together under a single locality specimens from numerous stations.

Particularly in his work on land mollusks, Hemphill proposed many trinomials for entities that today are regarded merely as intrapopulational variants. Most have been synonymized by subsequent workers, but they have to be kept in mind if it is found that additional taxa can be recognized in the groups involved.

Manuscript names accompanying Hemphill material in various collections and the *nomen nudum* in his catalogues suggest that, given the opportunity, he would have proposed a great many more varieties. Some of these manuscript names were picked up and made available by other authors, who often simply credited them to Hemphill. In reality, the names should be fully credited to these later authors, since they are responsible for the conditions that made them available.

Hemphill is well known for reporting his localities in vague terms, and it has been speculated that he did so to prevent other collectors from finding the habitats of some of his more unusual taxa.

Hemphill amassed huge lots, in part because he made money from the sale of duplicate material. As a result of his sales and his exchanges, what must now be interpreted as type material of his taxa ended up in many institutions.

Hemphill labeled a few lots in the California Academy of Sciences, and the Stanford University collections as "types." However, he did not designate individuals as holotypes in his publications. Thus, we regard the specimens labeled "types" as syntypes, though they are perhaps the best specimens from which a lectotype might be designated.

Hemphill evidently returned to his productive localities repeatedly and collected additional material. Thus, in a number of cases there are many more "syntypes" than the number of specimens he claimed he had in hand when he prepared his original description. We have merely indicated when this is the case, leaving the interpretation of his material and the selection of lectotypes up to systematists working on the particular groups involved.

In his papers on mollusks, he introduced some 107 names, mostly of land snails. Twenty of these are *nomina nuda*. Of the 87 available names, 53 are now regarded as synonyms, and 34 are currently recognized as valid. We have located type material of all but one of his available taxa. Other workers introduced 20 names that he coined, of which 6 are *nomina nuda* and 14 are available.

* * * * *

The Molluscan Fauna of the San Bernardino Mountains

[Abstract]

C. Clifton Coney

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A total of 37 species and subspecies representing thirteen families of freshwater and land mollusks has been reported in the literature as occurring in the San Bernardino Mountains. This report identifies 7 previously unreported taxa, bringing the number of mollusk taxa known to occur in the San Bernardino Mountains to a total of 44. Information on species that have not been previously reported from this region was gleaned from the Wendell O. Gregg collection, which is deposited at the Los Angeles County Museum of Natural History.

* * * * *

Systematic Position of Quincuncina mitchelli (Simpson, 1896) (Unionidae)

[Abstract revised November 12, 1985, based on new evidence]

C. Clifton Coney

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and

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Examination of the soft anatomy of both male and gravid female specimens of *Unio mitchelli* Simpson, 1896, from the Llano River, Texas, has revealed that the systematic treatment of this species by Haas (1969), in the "Superfamilia Unionacea" of *Das Tierreich*, is not correct. Until now, the soft anatomy was unknown and the assignment to *Nephronaias* (*Sphenonaias*) was based entirely on shell characters. The marsupial demibranchs of two gravid females clearly demonstrate a tetragenous condition rather than an ectobranchous one as previously assumed. Other specimens reveal that the supra-anal mantle connection, between the anal and supra-anal apertures, may or may not be present. *Unio taumilapana* Conrad, 1855, from the Rio San Juan of the Rio Grande drainage, Mexico, was not sufficiently described to permit its application to any known species with certainty, has never been illustrated, and the type is apparently lost. We regard *taumilapana* Conrad as a nomen dubium, and adhere to *mitchelli* Simpson, 1896, for the central Texas species. Allocation of *mitchelli* Simpson to *Quincuncina* is supported by both anatomical and shell characters.

Anatomical specimens of *U. mitchelli* reported here are part of Dwight W. Taylor collection deposited at the Los Angeles County Museum of Natural History.

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Minute Marine Molluscan Species Collected in the Hawaiian Islands which are not Included in the book "Hawaiian Marine Shells by Alison Kay"

[Abstract]

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A total of 39 species of minute marine mollusks from collections by the author and others from the Hawaiian Islands were found to be sufficiently different than any shown in Kay's **Hawaiian Marine Shells** to justify considering them valid different species. In several cases closely related species are shown for comparative purposes. The author found it difficult to find descriptions and names for many of these species and some may be new. Most of the author's collection came from Kawaihae Harbor on the Northwest coast of Hawaii and from that location 7 additional species of the family Pyramidellidae not shown in Kay's book proved to be identical to species described from Southern California. It is probable that these shells were accidentally imported on U.S. Marine Corps landing craft during practice landings at the Kawaihae Harbor. Some of these craft were said to have been brought over from Long Beach, California during the last few years.

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Minute Marine Shells of the Hawaiian Islands - Changes from the Taxonomic Placement in "Hawaiian Marine Shells"

[Abstract]

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Two recent publications by W.F. Ponder of Australia, one on the family Barleeidae in 1983, the other on the family Rissoidae in 1985, report several revisions that change the taxonomic placement of several species treated by Kay in her fine book, **Hawaiian Marine Shells**, released in 1979. These changes affect both generic and family placement. In addition recent research by the author has indicated that three other changes in family placement appear justified. Slides showing most of the species involved are shown and a list of the changes is available to those desiring it.

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Malacological Investigations in Quintana Roo, Mexico

[Abstract]

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While the opisthobranch fauna of the western Atlantic has been fairly well studied, most collections have been made from the islands of Bermuda, Barbados and Jamaica. Few studies have dealt with the continental portions of the region and no studies have focused on the Atlantic coast of Mexico. In March & April 1985, we conducted a preliminary survey of the opisthobranch gastropod fauna of the State of Quintana Roo, Mexico. Investigations by means of Scuba diving and snorkelling were made. Collections from Cancun, Cozumel, Puerto Morelos and Punta Allen included living coral reef, coral rubble, *Thalassia* flat and mangrove communities.

Thirty-one species of opisthobranchs were collected from the above-mentioned localities. As there are no published records of opisthobranchs from Quintana Roo, all of these constitute range extensions. Most of these species are known from other portions of the western Atlantic and several species are known elsewhere from the eastern Atlantic or are circumtropical. However, five of the species collected are new to science. The systematics and distribution of these taxa are currently being more fully studied.

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Additions to the Opisthobranch Gastropod Fauna of the Hawaii

[Extended Abstract]

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The molluscan fauna of the Hawaiian Islands is one of the best known among the western and central Pacific Islands. The landmark compilation of Kay (1979) represents a watershed of our knowledge of Hawaiian marine mollusks. She reported a total of 137 species of opisthobranchs (32 Cephalaspidea, 9 Anaspidea, 18 Sacoglossa, 9 Notaspidea and 69 Nudibranchia). However, the total includes several unidentified or misidentified taxa: e.g., Fig. 150H is not *Chromodoris imperialis* (Pease, 1860), but represents an other described species; Fig. 147E, *Halgerda* sp. cf. *graphica*, has since been named *H. terramtuensis* Bertsch & Johnson, 1982; and Fig. 155C, *Flabellina* sp. is *F. alisonae* Gosliner, 1980. These kinds of nomenclatural problems suggest that the opisthobranch fauna may not be as well known as the fauna of other molluscan taxa.

Since Kay's monograph on the Hawaiian molluscan fauna appeared, several additional taxa have been reported from the Hawaiian Islands: (Bertsch & Johnson, 1979, 1982; Gosliner, 1980a; Willan, 1984).

Our collecting and research further support the contention that the knowledge of the Hawaiian opisthobranch fauna is far from complete. A preliminary tally of Hawaiian opisthobranch species known to us, results in a minimum of 130 additional species -- doubling the number of species known to occur in the Hawaiian Islands.

These additional species comprise three groups: 1) Previously described species that occur elsewhere in the Pacific Ocean, but have not yet been reported from the Hawaiian Islands (17 species); 2) Species in Kay (1979), Gosliner (1980b) and Bertsch & Johnson (1981) with taxonomic problems (20 species). (For example, *Halgerda rubra* of Kay (1979) represents at least three species in the two genera, *Aglaja orientalis* of Gosliner (1980b) represents an undescribed species (*A. orientalis* Baba, 1949 is placed in *Philinopsis*) and *Chelidonura hirundinina*, *Roboastrea gracilis* and *Hypselodoris infucata* of Bertsch and Johnson (1981) probably represent undescribed species); 3) apparently undescribed species that are known only from the Hawaiian Islands (at least 93 species).

In this report, as part of our continuing studies of Hawaiian opisthobranchs, we cite 17 species as newly reported members of the Hawaiian marine molluscan fauna. These species are all circumtropical or Indo-Pacific tropical/ subtropical in distribution, providing further evidence of the zoogeographical affinities of the Hawaiian marine mollusks (Kay, 1967, 1980; Zinsmeister & Emerson, 1979; Gosliner, 1980a; Bertsch & Johnson, 1983).

Chelidonura fulvipunctata Baba, 1938

Previously known distribution: Japan (Baba, 1938, 1949), Guam (Carlson & Hoff, 1972), Australia (Burn, 1966, as *C. conformata*), Turkey (Swennen, 1961, as *C. mediterranea*).

New record: Sand Island, Kaneohe Bay, Oahu, intertidal to 3m, May 1973, numerous specimens, *leg.* T. Gosliner.

Petalifera ramosa Baba, 1959

Previously known distribution: Japan (Baba, 1959), Florida (Marcus, 1972).

New Record: Kewalo Basin, Oahu, intertidal, August 1973, 1 specimen, *leg.* T. Gosliner.

Notarchus indicus Schweigger, 1820

Previously known distribution: Indo-Pacific from East Africa (Bebbington, 1974) to Japan (Baba, 1949).

New records: off Haleiwa, Oahu, 110m, October, 1973, 2 specimens, *leg.* T. Gosliner & G. Williams; Kure Atoll, June 1980, 1 specimen, *leg.* S. Johnson.

Phyllobranchillus orientalis (Kelaart, 1858)

Previously known distribution: Indo-Pacific from Ceylon to Japan and New Caledonia (Baba & Hamatani, 1971).

New record: Sand Island, Kaneohe Bay, on *Caulerpa racemosa*, 1m, April 1974, 4 specimens, *leg.* T. Gosliner.

Tambja morosa (Bergh, 1877)

Previously known distribution: Philippines (Bergh, 1877), Indonesia (Bergh, 1905), Australia & New Zealand (Willan & Coleman, 1984).

New record: Puako, Hawaii, subtidal, May 1978, 20mm long specimen, *leg.* S. Johnson.

Plocamopherus imperialis Angas, 1864

Previously known distribution: Australia & New Zealand (Willan & Coleman, 1984), Japan (Baba, 1949).

New record: off Haleiwa, Oahu, 110m, October 1973, 1 specimen, *leg.* G. Williams & T. Gosliner.

Kaloplocamus acutus Baba, 1955

(possibly a synonym of *K. yatesi* (Angas, 1864) (Willan & Coleman, 1984).

Previously known distribution: Japan (Baba, 1955).

New record: Pupukea, Oahu, 10m, May 1978, 11m long specimen, *leg.* S. Johnson.

Gymnodoris citrina (Bergh, 1877)

Previously known distribution: Japan, Palau, Guam, Australia, Samoa, Solomon Islands, Marshall Islands, Tahiti (Johnson & Boucher, 1984).

New record: 3.5km west of Nanakuli, Oahu, intertidal, 2 June 1977, 20mm long specimen, *leg.* H. Bertsch.

Goniodoris joubini Risbec, 1928

(listed as *G. sp. cf. joubini* of Kay, 1979, *G. glabra* Baba, 1937 is a probable synonym)

Previously known distribution: Australia (Willan & Coleman, 1984), New Caledonia (Risbec, 1928).

New record: Kewalo Basin, Oahu, intertidal, July 1973, numerous specimens, *leg.* T. Gosliner.

Okenia pellucida Burn, 1967

Previously known distribution: Australia, New Zealand (Willan & Coleman, 1984).

New records: Coconut Island, Kaneohe Bay, Oahu, on the bryozoan *Zoobotryon* sp., on floating docks, October 1972, numerous specimens, *leg.* T. Gosliner; channel in Ala Wai, next to Magic Island, Oahu, *leg.* S. Johnson.

Platydorid scabra (Cuvier, 1804)

Previously known distribution: Indo-Pacific from South & East Africa to Marshall Islands (Edmunds, 1971).

New records: lagoon, Kure Atoll, 3-10m, under rocks, *leg.* S. Johnson; Makua and Pupukea, Oahu, 3-5m, under ledges and in caves, *leg.* S. Johnson.

Miamira sinuata (Hasselt, 1824)

(Jolly green giant of Bertsch & Johnson, 1981)

Previously known distribution: Sunda Strait, Java; Lord Howe Island (Willan & Coleman, 1984); Japan (Baba & Hamatani, 1974).

New record: Waialua, Oahu, 5m, August 1978, 20mm long specimen, *leg.* S. Johnson.

Dendrodoris denisoni (Angas, 1864)

(*D. gemmacea*) (Alder & Hancock, 1864) is a probable synonym)

Previously known distribution: East Africa (Eliot, 1904); Australia, New Zealand (Willan & Coleman, 1984); Japan (Baba, 1949); India (Alder & Hancock, 1864).

New records: off Haleiwa, Oahu, 110m, November 1972, several specimens, *leg.* T. Gosliner; Pupukea, Oahu, 15m, July 1978, 15mm long specimen, *leg.* S. Johnson.

Dendrodoris elongata Baba, 1936

Previously known distribution: western Pacific, including Japan, Okinawa, Vietnam, Australia, New Caledonia and Marshall Islands (Johnson & Boucher, 1984).

New record: Makua & Pupukea, Oahu, 3-5m, under ledges, *leg.* S. Johnson.

Janolus toyamensis Baba & Abe, 1970

Previously known range: Toyama Bay, Japan (Baba & Abe, 1970).

New records: Pacific Biomedical Research Laboratory, Kewalo Basin, Oahu, collected in laboratory sea water system, February 1973, 1 specimen, *leg.* T. Gosliner; Makua, Oahu, 5m, August, 1980, 10mm long specimen, *leg.* S. Johnson.

Notobryon bijercurum Baba, 1937

Previously known distribution: Sagami Bay, Japan (Baba, 1937).

New record: off Haleiwa, Oahu, 110m, August 1973, 1 specimen, *leg.* T. Gosliner.

Aeolidiella alba Risbec, 1928

Previously known distribution: Circumtropical, including South Africa, East Africa, New Caledonia, Australia, Pacific coast of Mexico and Barbados (Gosliner, 1985).

New records: channel in Ala Wai, next to Magic Island; Kewalo Basin; reef flats at Makapuu, all on Oahu, intertidal and shallow subtidal, *leg.* S. Johnson.

ACKNOWLEDGEMENTS

We thank Marilyn Switzer-Dunlap, Michael Hadfield and Gary C. Williams for their interest in Hawaiian opisthobranchs and for their assistance in collecting specimens.

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Cepaea nemoralis in British Columbia, Canada

[Abstract]

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The ecology and population dynamics of the garden snail *Cepaea nemoralis* have been studied for decades in Europe and Britain. To date only a small number of papers exist relative to its presence in Eastern North America. This study represents the first report of extensive populations of *Cepaea* in Western Canada.

The research presented involves 65 different colonies of *Cepaea nemoralis* from 7 areas of the Lower Fraser Valley. Over 10,300 snails have been examined with respect to color, banding, size, and behaviour. Populations range widely in density and size, and have distinct patterns of gene frequency distribution. Polymorphism is extensive and all major morph types are present, allowing correlation of color and banding polymorphism with genetic constitution, behaviour, habitat preference and predation. In addition, since neither the sibling species (*Cepaea hortensis*), nor the main predator, the song thrush (*Turdus ericetorum*), occur in B.C., population dynamics of *Cepaea* may be monitored in the absence of strong competition and with alternate predators. This paper will concentrate on the polymorphism, range and distribution of *Cepaea nemoralis* in the Lower Fraser Valley. Possible origins of some colonies with relation to the founder effect will be discussed. Preliminary analyses of ecology including habitat, and climate in relation to population stability and maintenance of polymorphism will be given for those populations examined in both 1984 and 1985. Area effects and climbing behaviour are also noted.

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An Unusual Spawning Method in Scaphopods

[Extended Abstract]

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The literature concerning reproductive activity in scaphopods is surprisingly meager. What is available concerns itself primarily with cleavage and development of the fertilized egg and the few anatomy and function oriented papers are mostly very old and inaccurate. For example, the most often cited work on the structure of the scaphopod reproductive organs (Lacaze-Duthiers, 1856. Histoire de l'organisation et du developpement du Dentale. Ann. Sci. Nat. Zool. 6(4):225-281) does not actually contain any information on the gonads at all, although it is very exhaustive in its treatment of other structures.

My investigations show that the methods of spawning followed by male and female *Cadulus fusiformis* and *Siphonodentalium quadrifissatum* (both Pilsbry and Sharp) are not the same. The two species are identical in structure, but due to their small size may differ from other members of the class.

The males of the species have a series of branching tissues that ramify throughout the testes. There is a gonoduct in the anterior and ventral portion of the organ that appears green when stained with trichrome. The duct leads through the right nephridial gland into the much-reduced hemocoel. Presumably the sperm are released from there into the mantle cavity through coelomoducts. The green color indicates that this is collagenous connective tissue.

As one proceeds more posteriorly and dorsally (away from the gonoduct) the branching tissue now stains red, indicating muscle tissue. In fact, at certain places parts of this tissue is contiguous with the retractor muscle. Mature sperm still line up head to tail along this tissue, and are closely associated with it. It is probable that contractions of this muscular branching tissue is what moves sperm into the gonoduct and accounts for descriptions of separate clouds of sperm being ejected during spawning.

The females of *Cadulus fusiformis* and *Siphonodentalium quadrifissatum* release eggs through an entirely different mechanism. The eggs of both of these species are quite large (200um to 300um) for the size of the animal (approx. 10mm). The only opening of this size that is available is at the posterior apex. No other potential gonoduct has been observed, and considering the size of the eggs, this structure would be hard to miss. The only way mature eggs can get into the cavity that leads to this opening is through dissolution of the inner membranes of the packages of the ovary. This allows the mature eggs (which are unattached to the interior of this membrane) to exit into the cavity where they can be moved to the posterior opening.

The inner lip of the posterior opening has several structures that stain red and appear to be glandular. It is hypothesized that this gland provides the mucous matrix of the ribbon in which some scaphopods are known to lay their eggs. This hypothesis is also in agreement with the fact that the posterior appendix of the mantle is more developed in females than in males. It also raises the possibility that some scaphopods may be fertilized internally rather than being strictly broadcast spawners.

Finally it is noted that neither eggs nor sperm develop synchronously, but that the late spring and summer months appear to be the more reproductively active months of the year.

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Cocos Island, Costa Rica

1985 Expedition

[Slide Presentation]

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The last two weeks in May of 1985, Kirstie Kaiser, Dr. Michel Montoya, and Dr. Donald Shasky embarked upon a shelling expedition to Cocos Island, Costa Rica. It was the first trip for myself and the third trip for both Drs. Montoya and Shasky. During our 10 days at Cocos Island, we collected using Scuba, intertidally, and shallow-water dredging from 17 to 85m. Our molluscan survey and work will continue at Cocos Island in 1986.

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Spawning Records of Eastern Pacific Gastropoda, I

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Accounts of spawning by marine gastropods are not uncommon in published literature, although they are scattered widely throughout malacological and biological journals. An

additional source of spawning information, one that is rarely utilized, is the accumulated field observations made by malacologists and shell collectors alike. The sporadic nature of these observations, together with the seeming unimportance as single records, precludes most of these observations from ever entering the published record. Nevertheless, the relative rarity of observations is such that a photographic record is often made of mollusks associated with, or in the process of depositing, egg masses.

The following list, the first of several, is an attempt at compilation and documentation of these unpublished occurrences. Future lists in this series will continue to provide an outlet for publication of spawning records. Data sheets for compilation and submission of spawning data are available from the author at the above address. Individual records cited herein should be credited to the original observer and not to the compiler of this list. Questions concerning the details or validity of these occurrences should be addressed to the original observers.

The format used is as follows:

FAMILY [family # of Keen & Coan (1974)]

Genus species Author, date

Observer or Record holder, date of observation or collection. **Locality data**. Nature of observation or description of material collected; habitat where found. **Collector** (coll. #); photographic record (photo #). Other data or reference. [record #]

Mollusca: Gastropoda

TURRITELLIDAE [24]

Turritella gonostoma Valenciennes, 1832

Pitt, W.D. ____ December 1969. Empalme, Sonora, Mexico. Shell with egg mass; intertidal sand. **Pitt coll.**; color slide (128). Not collected. [1.1]

EPITONIDAE [28]

Asperiscala billeenana (DuShane & Bratcher, 1965)

DuShane, H. ____ March 1966. Bahia Las Animas, Baja California (Gulf side), Mexico. Laying eggs on host coral *Tubastrea aurea* (Quoy & Gaimard, 1824); depth 15ft. **DuShane coll.**; color slide. [1.2]

Epitonium elenensis (Sowerby, 1844)

DuShane, H. 15 March 1974. Matachen, Nayarit, Mexico. Egg capsules (approx. diameter 0.5mm) from sheet anemones on top surface of boulders. **DuShane coll.**; color slide. [1.3]

Nitidiscala tinctoria (Carpenter, 1864)

DuShane, H. 25 January 1979. Laguna San Jose, Baja California, Sur, Mexico. Seven animals with egg masses on rock; intertidal. **DuShane coll.**; color slide. [1.4]

JANTHINIDAE [29]

Recluzia palmeri (Dall, 1871)

DuShane, H. ____ April 1979. Matachen, Nayarit, Mexico. Egg capsules still adhering to shell; washed in on rising tide. **P. Covey, DuShane coll.**; color slide. [1.5]

CALYPTRAEIDAE [34]

Crucibulum spinosum (Sowerby, 1824)

DuShane, H. 25 January 1976. Laguna San Jose, Baja California, Sur, Mexico. Animal & closeup showing eggs within cup; attached to rock. **DuShane coll.**; color slide. [1.6]

CYPRAEIDAE [44]

Cypraea annettae Dall, 1909

Shasky, D.R. 27 May 1961. South side of Bahia San Luis Gonzaga, Baja California, Mexico. Female animal with egg mass attached to dorsal surface of shell; intertidal under rocks. **Shasky coll.**; color slide. [1.7]

OVULIDAE [45]

Neosimnia aequalis (Sowerby, 1832)

Pitt, W.D. ____ February 1970. Mouth of Estero Miramar, Guaymas, Sonora,

Mexico. Specimen associated with egg mass; on gorgonian coral. Pitt coll. (936AA); color slide. [1.8]

THAIDIDAE [51]

Acanthina spirata (Blainville, 1832)

Keen, A.M. 30 April & 1 May 1934; 7 am. Princeton beach, San Mateo Co., California. Spawning colony; intertidal, during one of lowest tides of the year. No. coll.; B&W 2x3" negs. & prints (to be deposited in Invert. Zool. Sect., LACMNH). Ref.: A.M. Keen *in litt.* to G.L. Kennedy, 26 June 1984. [1.9]

Pitt, W.D. ____ July 1966. Dillon Beach, Marin Co., California. Several individuals and egg capsules; rocky intertidal zone. Pitt not coll.; color slide (54). [1.10]

Nucella emarginata (Deshayes, 1839)

Kennedy, G.L. 21 June 1977. N. end of Moonstone Beach, Humboldt Co., California. Egg capsules associated with spawning (?) individuals; intertidal, barnacle-covered beach rock. No coll.; color slide (GK-77-VI-21). Ref.: Field Notebook #2, p. 106. [1.11]

BUCCINIDAE [52]

Solenosteira macrospira Berry, 1957

Pitt, W.D. 26 March 1967. San Felipe, Baja California (Gulf side), Mexico. Observation; habitat. Pitt coll. (1121AA); color slide (114). [1.12]

COLUMBELLIDAE [54]

Mazatlanian fulgurata (Philippi, 1846)

Pitt, W.D. ____ February 1971. Rincon de Guaybitos, Jalisco, Mexico. Four specimens with eggs attached to shells; sandy bottom. No coll.; color slide (271). [1.13]

NASSARIIDAE [56]

Nassarius brunneostoma (Stearns, 1893)

DuShane, H. ____ May 1960. San Felipe, Baja California (Gulf side), Mexico. Specimen with egg capsules on foot; intertidal. F. Howard! DuShane coll.; color slide. [1.14]

FASCIOLARIIDAE [57]

Fusinus sp.

Pitt, W.D. ____ February 1970. San Carlos Bay, near Guaymas, Sonora, Mexico. Two specimens with egg capsules; underside rocks. Not coll.; color slide (272). [1.15]

ACTEONIDAE [102]

Rictaxis punctocaelatus (Carpenter, 1864)

Pitt, W.D. ____ August 1966. Tomales Bay, Marin Co., California. Individual with eggs; intertidal sandy beach. Pitt coll. (69-A-1); color slide (86). [1.17]

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Paleoclimatic Implications of Quaternary Marine Invertebrate Faunas from Southwestern Santa Barbara County, California

[Extended Abstract]

George L. Kennedy

Section of Invertebrate Paleontology
Los Angeles County Museum of Natural History
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and

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Marine wave-cut terraces that record past sea-level events are moderately well developed along the southwestern coast of Santa Barbara County in southern California. The faunas on these terraces are important because of their geographic proximity to Point Conception, a major provincial boundary throughout Quaternary time, and because they document marine paleoclimatic conditions that existed during sea-level high stands in the Holocene (marine oxygen-isotope Stage 1) and during the last interglacial period (Stage 5, substages 5a, 5c, 5e).

Fossil faunas that are diverse enough to allow paleoclimatic reconstruction have been collected from six localities along this coastline; these are, from west to east: 1st terrace at east end of Cojo Bay; 2nd terrace at Alegria Canyon; midden material in Agua Caliente Canyon; 1st terrace west of Gaviota State Beach; and 1st and 2nd terrace at Arroyo Hondo.

Differences in marine temperature suggested by invertebrate faunas from terraces of similar elevation can be explained by superimposing the effects of an eustatically fluctuating sea level onto a coastline that is undergoing local and (or) regional uplift such that terraces of differing ages (and with faunas of different zoogeographic aspect) are uplifted to different levels above modern sea level. In tectonically stable areas, the lowest emergent terrace is often that formed approximately 125,000 years ago (substage 5e), when sea level was approximately 6m higher than it is today, and the oceans slightly warmer. In areas with higher uplift rates, such as along much of the Santa Barbara County coast, the lowest emergent terrace normally will date to a later period, such as 82,000 years BP (substage 5a) or 103,000 years BP (substage 5c), when sea level was perhaps lower by 10-15m, and the oceans slightly cooler than they are today. Ages of terraces in the study area have been inferred from amino acid enantiomeric (D/L) ratios in mollusks.

Cool-water faunas

The cited terrace faunas from Cojo Bay, Alegria Canyon, Gaviota, and Arroyo Hondo (1st terrace) all date to middle or late Stage 5 (substages 5a, 5c). The vary considerably in species diversity and abundance of material, but all are zoogeographically similar and indicate marine temperatures no warmer than those occurring today in the vicinity of Monterey Bay, California. At least ten extralimital northern species are present in these cool-water faunas; three species (*Penitella turnerae* Evans & Fisher, *Saxidomus giganteus* (Deshayes), and *Semibalanus cariosus* (Pallas)) are present in all of them. The modern latitudinal equivalency of these fossil faunas is additionally defined by approximately twelve species whose terminal northern occurrences lie along the central California coast, most between Monterey Bay and Bodega Bay. Only *Acanthina spirata* (Blainville) is present in all four faunas, but six species occur at Cojo, five at Alegria, eleven at Gaviota, and nine at Arroyo Hondo.

Warm-water faunas

The collection from Agua Caliente Canyon, although of Holocene age and probably of aboriginal origin, contains two or possibly three bivalves that have extralimital southern ranges (*Argopecten aequisulcatus* (Carpenter), *Chione californiensis* (Broderip), and *C. undatella* (Sowerby)). These are, however, just extralimital and all have northern endpoints between Goleta and Carpenteria. Given suitable embayments along the coast between Santa Barbara and Point Conception, all of these species would probably occur farther westward. Thus the limiting factor may be the lack of a suitable habitat, that is, a protected lagoon or estuary, rather than a need for slightly warmer oceanic temperatures. Marine temperatures along the Santa Barbara coast during the Holocene rise in sea level, when this fauna probably lived in the drowned mouth of Agua Caliente Canyon, are inferred to have been similar to those of today.

The fauna from the second, substage 5e terrace at Arroyo Hondo contains four gastropods that have extralimital southern ranges. The northern range endpoints of three of these (*Opalia funiculata* (Carpenter), *Pteropurpura festiva* (Hinds), and *Terebra pedroana* Dall), Refugio State Beach, Santa Barbara, and Oxnard, respectively, are not significantly south (or east) of their fossil occurrence at Arroyo Hondo. *Acanthina lugubris* (Sowerby), however, occurs today only as far north as Ensenada and vicinity (LACMNH records), although it has been reported as far north as San Diego. This species is thus extralimital by 300 to 400km. The modern latitudinal equivalency of this fauna is additionally constrained by several other species in the fauna, including *Clinocardium nuttalli* (Conrad), which is known only as far south as San Diego, and five species whose terminal southern endpoints are at Santo Tomas, Camalu, and Isla San Martin, all in northwestern Baja California. This fauna indicates oceanic temperatures similar to those of the northernmost Baja California - southernmost California coast for this part of the Santa Barbara coast during substage 5e, approximately 125,000 years ago.

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Augmented Encrusting Algal Recruitment onto Shells of Active Herbivorous Gastropods

[Abstract]

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Anachis avara semiplicata Stearns (Columbellidae) and *Diastoma* (= *Bittium*) *varium* Pfeiffer (Cerithiidae) reach densities over 200/m² in shallow turtlegrass meadows. These snails selectively consume diatoms and mature coralline algae, but do not appear to deplete their foods. Browsed areas of algae grow back readily, and removed spores and vegetative algae grow back readily, and removed spores and vegetative algal cells resettle, particularly on actively foraging snails. Dead shells, hermit crabs on the sandy bottom, and experimentally immobilized shells in seagrass beds of aquaria do not accumulate algae nearly as quickly as foraging snails do.

Cultures of snail fecal pellets in filtered seawater under natural lighting and temperatures show very frequent survival of consumed algae passing through the feces. Algal recruitment via the activities of such dense snail populations may be as frequent as planktonic recruitment of these shallow-water algae.

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Sinistrality in Pupilla (Pulmonata: Pupillidae): Geographic Distribution and Reproductive Isolation from Dextral Conspecifics.

[Abstract]

Peter B. LaRochelle
University of Colorado
Colorado

The land snail genus *Pupilla* (Pulmonata: Pupillidae) is found throughout much of North America, excepting the south central and southeastern United States. In the Central and Southern Rocky Mountains, *Pupilla* has a broad environmental tolerance ranging from oak woodland and dry grassy slopes on the xeric extreme to mesic deciduous forest. Whereas dextrality predominates in the genus *Pupilla*, sinistrality has been reported in four North American species, *P. hebes*, *P. syngenes*, *P. muscorum*, and *P. blandi*.

A coiling transition zone for *Pupilla hebes* is described from the Santa Catalina Mountains, Pima County, Arizona. The reproductive isolation between chiral opposites from this site was assessed from sympatric field-collected samples and laboratory crosses. The evolution of sinistrality in North America also is appraised.

The microdistribution of sinistral *Pupilla* was nonrandom. The xeric end of the sample transect (Oracle Ridge; pine-locust to oak-juniper woodland) bore entirely sinistral colonies. The mesic end of the transect (Mt. Lemmon; mixed aspen-conifer woodland) was predominantly dextral with some sinistral colonies at mesic sites proximal to Oracle Ridge.

In North America, sinistral *Pupilla* are reported from the Eastern Great Plains and desert Southwest in the Pleistocene and are Recent in the latter only. Sinistral *Pupilla* has evolved only on the arid margins of its range in western North America.

A causal relationship between arid environments and the establishment of sinistral populations is hypothesized. It is suggested that as habitat insularity increases (e.g., the desert-bounded mountain ranges of Arizona and the riparian corridors of the Great Plains) the ratio of mesic to xeric habitat surface area decreases. Under such conditions it is hypothesized that sinistral colonies generated on the arid "island" periphery can reach a steady state existence with dextral colonies in the mesic "island" interior. However, where this ratio is relatively large, sinistral colonies generated on the arid margin will be swamped by differential colonization by dextral immigrants following local extinctions. It also is hypothesized that sinistrality in *Pupilla* has arisen independently many times.

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The Trochid Genus Lirularia Dall, 1909: A Filter Feeder?

[Abstract]

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Lirularia is a small-shelled genus (shell height 3-7mm) with variegated color patterns, associated with rock and algal habitats in shallow water. Seven species are known in the northeastern Pacific and two from the northwestern Pacific. It has long been known that the rhipidoglossate radula of *Lirularia* species is of the umboniine type with reduced shaft and cusps. Fretter (1975) showed that the gill of *Umbonium* is monopectinate, with greatly elongated filaments attached only at the base (unlike the monopectinate ctenidium of

higher prosobranchs in which filaments are fused to the mantle skirt) and that the epipodial structures are modified to assist in filter feeding. For this study, a specimen of *Lirularia lirulata* (Carpenter, 1864), the type species of *Lirularia* was relaxed in $MgCl_2$, removed from the shell, fixed in Bouin's, critical-point dried, and gold-coated for examination with SEM.

The gill of *Lirularia* resembles that of *Umbonium*, although there are fewer filaments. As in *Umbonium* (and other trochids), each filament has a prominent "sensory bursicle," as first described by Szal (1971). The frontal, lateral, and terminal cilia of the filaments are readily apparent when examined with SEM. A ciliated tract on the right side of the mantle cavity evidently functions as a food groove, where it is overlain by the tips of the filaments. The snout of *Lirularia* is broad like that of most trochids (unlike the narrowed snout of *Umbonium*), although the tip of the snout has a ringlet of small tentacles that lack sensory cilia; similar tentacles occur on the snout of *Umbonium*. The left neck lobe of *Lirularia* is digitate (as in many other trochids), not expanded to form a siphon enveloping the left cephalic tentacle, as in *Umbonium*. Unexpectedly, tufts of sensory cilia were found on the neck area, extending within the mantle cavity; similar structures were not found in four other trochaceans that were also examined with SEM.

The homology of the radula, gill filaments, and snout tentacles clearly indicate that *Lirularia* is related to *Umbonium* and should continue to be placed in the trochid subfamily Umboniinae. Field studies are needed to determine the importance of filter feeding in the feeding budget of *Lirularia*, as most other prosobranch filter feeders also have the capacity to ingest food in more conventional ways. *Lirularia* moves rapidly; it is unique among prosobranch filter feeders in being neither infaunal nor epifaunal and sedentary. The evolutionary origin of *Lirularia* is another problem; it could represent a step in the specialization leading to *Umbonium* or the return to a hard substratum of an infaunal umboniine.

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Morphological Relationships among *Micrarionta* spp., Land Snails Endemic to the California Islands (Pulmonata: Helminthoglyptidae) [Abstract]

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Micrarionta is a genus of 7 recognized species of land snail endemic to the four southern California Channel Islands, USA, and Guadalupe Island, Mexico. Of special interest is the evolutionary relationship between the extinct *M. sodalis* (Hemphill, 1901) and the extant *M. opuntia* (Roth, 1975) on San Nicolas Island. *M. sodalis* persisted from earlier than 127,000 years before present to less than 5,000 YBP. *M. opuntia* appeared in the stratigraphic record of the island less than 5,000 YBP. Stratigraphic evidence indicates that the two species coexisted briefly in the geologic history of the island. Two lines of evidence suggest that *M. opuntia* is not an introduced faunal element, but evolved in place on San Nicolas Island from *M. sodalis*: 1) The rare occurrence of an extinct population of snails apparently intermediate in shell characters between *M. sodalis* and *M. opuntia* may represent a transition between the two taxa; 2) Preliminary cluster analysis and discriminant function analysis of shell morphology (mensurate characters) suggest that *M. opuntia* and *M. sodalis* are more similar to each other than either is to any other species. Changes in climate or activities of native Americans may have played roles in the extinction of *M. sodalis*. Radiocarbon dating will provide better resolution on the timing of the morphological transition from *M. sodalis* to *M. opuntia*. I am conducting further morphological analyses using larger sample sizes of all known taxa of *Micrarionta* which I

expect will strengthen the view of Holocene evolution of *M. opuntia* from *M. sodalis*, and such analyses should provide insight into the relationships between the other *Micrarionta* species.

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Gastropod Evolutionary Patterns: Perissitys and its Allies

[Abstract]

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Five species from the Late Cretaceous Coniacian Stage that are related to the gastropod genus *Perissitys* are of similar shape and sculpture. All are bucciniform and have axial ribs strongest at the whorl periphery overridden by spiral riblets. Their apertures are armed with similarly placed columellar and labral denticulations, and the outer lip is posteriorly and medially sinused or notched. Lineages descended from five species each comprise a series of forms in which each geologically younger form differs from its predecessor by accentuating morphologic features usually considered to be of only specific importance. Accumulations of these differences produce, before the end of the Cretaceous, six different genera. Their pattern of evolution during approximately 35 m.y. fits neither gradualistic nor punctuational diagrams. Unlike the punctuational model, change continues without stasis and within phyletic lineages; but, although gradual change is continual, periods of more rapid morphologic alteration occur. This evolution of lineages suffices to produce distinct genera in less than 10 m.y.

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The Unusual Hinge of Adontorhina Berry, 1947 (Bivalvia, Thyasiridae)

[Abstract]

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The minute thyasirid *Adontorhina cyclia* Berry, 1947, has one of the most unusual bivalve hinges. As the generic name implies, *Adontorhina* is without true teeth but has a coarse hinge plate which is like a rasp or file. Examination of the hinge plate under high magnification shows a highly complex structure. The hinge plate, which is composed of separate anterior and posterior sections, is covered with minute granules. The granules intermesh in a manner strikingly similar to mammalian molars. The granules are exceedingly variable in pattern and extent. In the many hundreds of specimens I have observed, no two granule patterns are alike. This variability between specimens does not seem to be correlated with different environmental conditions, as the individuals collected in a single 0.1m² infaunal sample all have distinctly different patterns. The unique qualities of the hinge granules of each specimen is indeed very reminiscent to the uniqueness of human fingerprints.

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"Endemic" Hawaiian Species Taken at Cocos Island

[Abstract]

Donald R. Shasky
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With one exception I have previously reported the occurrence of the species, cited below, that were thought to be endemic to Hawaii. These species are also found at Cocos Island, Costa Rica. The exception is starred.

Isognomon inclusis (Conrad, 1837)*
Metaxia brunnicephala (Kay, 1979)
Cypraea alisonae (Burgess, 1983)
Favartia garretti (Pease, 1869)

To say that *Cypraea alisonae* is endemic to Hawaii is not correct as Dr. Burgess, in his description of the species, cited American Samoa and Western Australia as additional habitats. It is included here since the center of its population seems to be the Hawaiian chain. A single specimen of *Favartia garretti* is also known from the Mexican mainland.

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Update on Mollusks with Indo-Pacific Faunal Affinities in the Tropical Eastern Pacific IV

[Abstract]

Donald R. Shasky
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Additional collecting at Cocos Island, Costa Rica, has added the following Indo-Pacific species to the Panamic fauna:

Isognomon incisus (Conrad, 1837)
Cardita aviculina (Lamarck, 1819)
Triphora triticea (Pease, 1861)

Although Dr. Frank Bernard has previously reported the cosmopolitan species *Malleus regulus* (Forsk., 1775) and *Lopha folium* (Linnaeus, 1758) in the tropical eastern Pacific, he did so without any specific locality. *Malleus regulus* is very common under the spines of *Spondylus nigrobaricus* (Schreiber, 1798).

The bivalves were identified by Dr. Bernard and the *Triphora* was identified by Bert Draper.

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New Occurrences of the Tethyan Gastropod Velates perversus in the Early Eocene of California

[Abstract]

Richard L. Squires
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Northridge, California 91330

The neritid gastropod *Velates perversus* (Gmelin) ranges from the late Paleocene (Thanetian) through the middle Eocene (Lutetian), a 15 million-year interval of time. The species is indicative of warm seas influenced by the equatorial Tethys Sea. *Velates perversus* originated in the western Pakistan-Indian region and spread into the Persian Gulf, eastern Africa, Mediterranean, and western European regions, as well as into Florida, Jamaica, Panama, and California. It was one of the most widespread species in Eocene seas.

In California, *V. perversus* occurs only in early Eocene (Ypresian) strata. It has been found previously only in the early Eocene ("Capay Stage") portion of the Juncal Formation, Pine Mountain area, and in the late early Eocene (lowermost "Domegine Stage") portion of the Avenal Formation, Coalinga area. Field work by the author has revealed two new Californian occurrences; namely, 1) one locality in the early Eocene ("Capay Stage") portion of the Maniobra Formation, Orocopa Mountains, eastern side of the Salton Sea area, and 2) six localities in the early Eocene ("Capay Stage") portion of the Juncal Formation, Piru Lake area.

All the Californian occurrences are in transgressive nearshore marine deposits in the basal portions of formations that have unconformities at their bases. Biotic associates most commonly in the same beds are *Nerita (Amphinerita) eorex*, *Turritella andersoni*, and *Ostrea haleyi*. Other biotic associates which can be in the same faunal zone include the mollusks *Clavilithes tabulatus*, *Gisortia clarki*, *Campanilopa dilloni*, *Chedevillia saltonensis*, *Miltha packi*, *Venericardia (Pacifcor) lutmani*, *Fimbria*, *Plicatula*, and the large benthic foraminifer *Pseudophragmina (Proporocyclina)*.

The arrival of *V. perversus* on the West Coast during the early Eocene at approximately 54 to 55 million years ago was coincident with the maximum geographic dispersal for the species. This time also coincided with a major global sea-level rise (TE1.2), and equatorial paleocirculation of surface waters was largely unrestricted worldwide. This was probably also the warmest time of the Cenozoic. The presence of *V. perversus* in the various basins of deposition along the West Coast further attests to the fact that the waters that circulated within the basins were also unrestricted.

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Food Selection and Nocturnal Behavior of Monadenia hillebrandi mariposa A.G. Smith

[Abstract]

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Eotvos University
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and
Department of Biology
University of Chicago

Some aspects of the natural history of an endemic Californian snail, *Monadenia hillebrandi mariposa* A.G. Smith, were studied. The snails live on the limestone outcrops of the western foothills of the Sierra Nevada. The food selection and nocturnal behaviour of the species were studied in laboratory experiments. Feces analyses were carried out to gain information about the diet of the animals in the field.

In the laboratory larger animals tend to spend more time crawling, less time feeding, and travel longer distances than smaller ones, although they exhibited high individual variability.

The food selection of the adult and juvenile snails was similar. Both the feeding experiments and the feces analyses indicate that *Monadenia hillebrandi mariposa* has a broad diet, but tends to prefer dead plant material, especially leaf litter. Animal matter was only accidentally ingested. Soil occurred in the feces samples very often and its relative amount was also high. Lichens, that grow on rock surfaces, were also found in the majority of the feces samples. However, they were not among the most preferred food items in the laboratory. Among the 9 different food types provided in the feeding experiments, grass and pine litter were the least selected. They were found on the edges of the limestone outcrop from which the snails were collected.

To understand the food selection of *Monadenia hillebrandi mariposa* more information is necessary about the nutritional needs of the species and about food availability in the field.

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Shell Fouling Organisms of Olivella biplicata (Sowerby, 1825) and Hermit Crab Behavior

[Abstract]

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Berkeley, California 94720

Olivella biplicata (Sowerby, 1825) is an abundant gastropod in the Neogene marine fossil record of California. In life, *O. biplicata* is mostly an infaunal snail with a clean glossy shell enclosed by parapodial flaps. In death, *O. biplicata* shells can be posthumously resurrected and exposed as a substratum for fouling organism settlement by hermit crabs. Thus, hermit crab occupation of fossil *O. biplicata* shells has been inferred from the presence of organisms associated with the shell, such as spionid polychaetes inhabiting the

columella of the shell or boring bryozoans on the ventral (apertural) side of the shell. However, my work on *O. biplicata* at Bodega Bay, California illustrates some of the difficulties in determining whether a fossilized shell has been inhabited by a hermit crab or not. For instance, living *O. biplicata* snails may house a colony of boring bryozoans on the aperture side of the shell — a characteristic that could be used in the fossil record to infer that a hermit crab had inhabited the shell. Further, although hermit crabs are generally assumed to maintain the shell above the sediment-water interface, I have been studying a hermit crab, *Isocheles pilosus*, that burrows and keeps the *O. biplicata* shells below the sediment-water interface. In this case, the snail and hermit crab have shells almost essentially free of epibionts (but not endobionts) in contrast to the epifaunal *Pagurus granosimanus* inhabiting *O. biplicata* shells well-camouflaged with a cover of algae and encrusting bryozoans (and occasionally barnacles). Therefore, hermit crabs may not necessarily expose shells to epifaunal fouling organisms and infaunal snails are not as pristine as we would like to believe.

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MINUTES, EXECUTIVE BOARD MEETING — 18 August 1985
Western Society of Malacologists
University of California, Santa Barbara

Present: William Pitt, Paul Scott, Terrence Gosliner, George Kennedy, Matthew James, Margaret Mulliner, Don Shasky

The meeting was called to order by William Pitt at 10:06 am.

Treasurer's Report: Margaret Mulliner presented the Treasurer's Report. As of 18 August 1985 the Society had a balance of \$9,484.16 in the treasury (see attachment A).

MSP to accept Treasurer's Report as presented.

Secretary's Report: Paul Scott read the minutes from the 1984 meeting. George Kennedy had a few minor corrections to the minutes which he presented to the secretary.

MSP to accept the minutes of the 1984 Executive Board Meeting as corrected by George Kennedy.

1985-86 Officers: Chairman of the Nominating Committee, George Kennedy, presented the following slate of officers:

President	Terrence M. Gosliner
1st Vice President	Carole M. Hertz
2nd Vice President	Matthew J. James
Secretary	F.G. Hochberg
Treasurer	Margaret Mulliner
Members-at-Large	Kirstie Kaiser, Paul Scott

MSP to accept the slate of officers as presented.

Selection of Editor: Bill Pitt announced that there was no definite editor at this time. Pitt asked for the feeling of the executive board on designating an editor for 1985-86. The general consensus of the board was to have Steve Long continue as editor. Pitt will ask Steve Long to continue as editor.

The Editorial Review Board was discussed. Kennedy asked if the president or the Executive Board appointed the review board. Shasky stated the executive board made the appointments. Pitt recommended that the members of the 1984-85 review board be asked to continue in 1985-86.

1986 Annual Meeting: Terry Gosliner reported that the 1986 meeting will be a joint meeting with the American Malacological Union. The meeting will be in Monterey, California from 1-6 July. The cost of lodging at the Sheraton Inn will be \$95 per night, with 1-4 people per room (meals not included). With the assistance of AMU president, Jim Nybakken, a list of less expensive hotels and local campgrounds is being assembled. This list will be circulated to members in the near future so they may make reservations early. The registration fees have not been set.

The shell and book auction at the 1986 meeting was discussed. Gosliner suggested that WSM hold a separate auction. There was general agreement to this suggestion.

As the 1986 meeting was approved by the members at the 1984 Annual Business Meeting no motion was necessary for approval of the meeting.

Student Grant Committee: As no members of the committee were present no report was given.

Budget 1985-86: Pitt mentioned that expenses in the coming year will be low due to the joint meeting. The only expected expenses will be publication and distribution of the annual report, and general membership correspondence costs.

There was a brief discussion to share the costs of the 1986 meeting with the AMU as it will be a joint meeting. Gosliner will look into this possibility.

Annual Report for 1986: There was an extended discussion on the content of the WSM Annual Report for the joint meeting. Gosliner suggested all WSM members will have the choice to publish in the WSM Annual Report, the AMU Bulletin, or both. Several board members expressed concern over publishing identical abstracts in two publication. It was generally agreed to give the members their choice of publication(s).

OTHER BUSINESS

1. **Project Data Log:** Kennedy gave a progress report on this project. Data sheets will be sent to members by Kennedy.
2. **Joint meeting with AMU:** Gosliner is continuing to push for complete joint status at the meeting in 1986. Barry Roth and Eric Hochberg, members of the joint meeting ad hoc committee, have sent letters to Jim Nybakken to ensure equal status of WSM at the meeting. Pitt will ask Gene Coan to also be on the ad hoc committee.
3. **Gratis copies of the annual report:** Considerable discussion on current status of gratis copies of annual report. Kennedy stated that gratis copies should only be sent to institutions not individuals. Mulliner stated letters have gone out to all gratis recipients as to whether they wish to continue receiving the annual report. Mulliner also reported that 6 institutions were dropped from the gratis list at the recommendation of Gene Coan, who was asked to review the list. Gosliner suggested a postcard acknowledging the receipt be included with all gratis copies. If the institution fails to return the acknowledgement they will be dropped from the list. Pitt will ask the editor for 1985-86 to develop these postcards and distribute them with the next annual report.
4. **Publication of the annual report:** Pitt stated the annual report should be published and sent to members within six months of the annual meeting. There was general agreement that the report should be out in a timely manner. It was also agreed that the report should not be delayed by individual papers or abstracts.

MSP Publication of abstracts and papers in the WSM annual report is contingent on the approval of the Editorial Review Board.

5. **Award for Service:** Pitt mentioned award for service has been confused with honorary life member. The award for service does not include a lifetime membership. The award is subject to approval by the executive board. Pitt further asked if anyone knew if there was a standard form or certificate for the award.

MSP The president will establish a standard form/certificate for the Award of Service to the Society.

6. **Date of annual meeting:** Pitt stated that the late date of the annual meeting is excluding students from the meeting, as many schools begin classes in August. Carole Hertz was asked into the meeting, she reported the 1987 meeting will be in June at San Diego State University. Gosliner suggested putting the question of meeting time to the members at the business meeting.
7. **Auction material:** Pitt encouraged board members to seek out donors of specimens and publications for the auction. Shasky mentioned some of his donated material was not accepted by the society.
8. **Revising official manual:** George Kennedy is currently revising the WSM officers manual and hopes to have it completed by the end of 1985.

There being no further business, the meeting was adjourned at 11:49 am.

Respectfully submitted

Paul H. Scott
Acting Secretary

Approved by

William Pitt
President (1984-85)

MINUTES
ANNUAL BUSINESS MEETING
Western Society of Malacologists

20 August 1985

Present: 39 members

The meeting was called to order by William Pitt at 3:40pm.

Secretary's Report: Paul Scott read the minutes from the 1984 Annual Business Meeting. George Kennedy stated that in 1983 Eric Hochberg summarized the minutes, rather than read them.

MSP to accept the minutes as read with correction by George Kennedy.

Treasurer's Report: Margaret Mulliner presented the Treasurer's Report for the period 16 August 1984 to 18 August 1985. (see attached).

MSP to accept report as presented.

Committee Appointments: President Pitt appointed the following committees:

Audit: Jules Hertz, Carole Hertz, David Mulliner
Parliamentarian: Eugene Coan
Student Grants: Vida Kenk
Student Awards: Terrence Gosliner, Henry Chaney

Editor: President Pitt stated Steve Long agreed to serve as editor for the 1985 Annual Report.

Abstracts and papers are due to Bill Pitt by September 15, 1985.

Election of Officers: Chairman of the Nominating Committee, George Kennedy presented the following slate of officers:

President	Terrence Gosliner
1st Vice President	Carole Hertz
2nd Vice President	Matthew J. James
Secretary	F.G. Hochberg
Treasurer	Margaret Mulliner
Members-at-Large	Kirstie Kaiser, Paul Scott

No additional nominations were submitted from the floor.

MSP to cast a unanimous ballot for the slate of officers as presented.

President Pitt thanked all of the 1984-85 officers and all who helped in the 1985 annual meeting. Pitt asked Carole Hertz to report on the 1985 auction. Hertz reported the proceeds from the auction were approximately \$1300. President Pitt then turned the gavel over to President-elect Terrence Gosliner. Gosliner thanked Pitt for an excellent meeting.

NEW BUSINESS

1. **Ad Hoc Committee on joint meeting with AMU:** B. Roth sent a letter to Jim Nybakken expressing the concern of the Society for full recognition a the joint meeting. Gosliner indicated that Nybakken was very aware of this sensitive issue. Gosliner and the ad hoc committee will continue to ensure the Society is properly acknowledged at the joint meeting.
2. **1986 Annual Meeting:** President Gosliner announced the 1986 Annual Meeting will be a joint meeting with the American Malacological Union and will be held 1-6 July at the Monterey Sheraton. The cost of lodging will be \$95/night, with 1-4 people per room. Gosliner is preparing a list of less expensive motels and hotels (in the \$50-\$60 range) within walking distance of the Sheraton. Gosliner will also prepare a list of nearby campgrounds. Gosliner and Nybakken have approached the Sheraton about a discount for students and senior citizens. Gosliner stated this joint meeting will be an exciting opportunity to showcase west coast malacology, and bury past differences.

There was an extended discussion about the meeting. With regard to the high cost of the meeting, Gosliner stated the \$95 rate was a discount rate, and the list of alternative hotels will be sent out soon. The meeting programs were discussed extensively. Gosliner stated the program will be a joint program with AMU, a preliminary schedule is available now and will be sent out soon. The program will be sent out by AMU and WSM will receive equal billing on the program. WSM members will have their choice to publish abstracts in the Annual Report or the AMU Bulletin or both. Gosliner felt the shell and book auction should be held separately from AMU. C. Skoglund suggested that the WSM concentrate on the shell auction and AMU could auction mollusk literature. Gosliner will take this suggestion under advisement.

3. **Auction:** Gosliner mentioned the 1985 shell and book auction was a tremendous success. Total profit was approximately \$1300, a new record for the Society.
4. **Change of meeting date:** Gosliner asked the members if they had any strong feelings as to the month when the Annual Meeting is held. C. Hertz mentioned the 1987 Annual Meeting will be in June. There was no strong feeling expressed by the members, and Gosliner asked individuals to contact him if they had a preference as to the date of future meetings.
5. **Resolution by terrestrial malacologists:** A resolution from B. Roth, W. Miller, R. Reeder, T. Pearch, P. LaRochelle, and E. Naranjo-Garcia was read by B. Roth.

Whereas the Bernice P. Bishop Museum, Honolulu, has the premier and unrivaled collections of Pacific Island land snails, including massive field collections that have not yet been curated and are therefore unavailable for study;

Whereas the native land snails fo the Pacific Islands include the only endemic families of all terrestrial groups inhabiting this region and contain about 95% endemic species;

Whereas, this fauna is rapidly becoming extinct and this is the last generation of scientists able to study living members of this fauna and learn from this unique assemblage;

Whereas, earlier in this century the Bernice P. Bishop Museum had the vision to establish these collections and build them to their incomparable status through the great collecting expeditions in the 1930's;

Whereas, the years of research on these collections by the late C.M. Cooke, Jr., and his associates such as H.B. Baker, William H. Clench, Yoshio Kondo, and Henry A. Pilsbry have resulted in publication of monographs which are acknowledged as classics;

Be it known that the Western Society of Malacologists, meeting in Santa Barbara, California, deplores the recent ending of support for both curation and research on terrestrial mollusks at the Bernice P. Bishop Museum.

While recognizing the financial difficulties that led to this suspension of research efforts, we strongly recommend that reestablishment of the position of Terrestrial Malacologist be given highest priority in any program to resume research activities at the Bernice P. Bishop Museum.

President Gosliner opened the floor to general discussion. Considerable discussion ensued about the finances of the Bishop Museum. T. Burch was highly supportive of the resolution but was concerned that it only mentioned terrestrial molluscs rather than all molluscan species.

MSP to adopt the resolution as read by Barry Roth.

MSP to send a copy of the adopted resolution to the principle newspapers in Honolulu, as well as the Board of Trustees at the Bishop Museum.

Discussion continued with regard to a financial donation from the Society to the Department of Malacology at the Bishop Museum. Several members expressed concern that this would be setting a precedent and that other museums would also ask for funds. T. Gosliner and P. Scott stated they felt this was an isolated incident and would not be setting a precedent. Concern was also expressed as to who would manage the funds at the Bishop Museum. C. Christensen stated Allen Allison, Chairman of the Department of Zoology is the curator in charge of the collection.

MS to donate \$500 to support the entire malacology collection at the Bishop Museum.

The wording of the motion was questioned, as to whether support of maintenance of the collections was more important. Members agreed that maintenance was the appropriate term. The motion was amended.

MSP to donate \$500 for maintenance of the entire malacology collection at the Bishop Museum.

It was also stated by several members that letters about the donation should be sent to appropriate newspapers as well as to the Board of the Bishop Museum. B. Roth and T. Gosliner agreed to send these letters.

6. **Resolution on publication of the Annual Report:** Dave Mulliner read the following resolution:

The members of the Western Society of Malacologists direct the editor and president to have the Annual Report published no later than December 31 of the meeting year.

B. Pitt stated the August meeting date precluded publication by the end of the year. Considerable discussion ensued as to the need to have abstracts and papers submitted before the meeting to insure time publication of the report.

MSP to direct the executive board to formulate and editorial policy and present this policy in the 1986 Call for Papers.

There being no further business, President Gosliner adjourned the meeting at 5:15pm.

Respectfully submitted

Paul H. Scott
Acting Secretary

Approved by

William Pitt
President (1984-1985)

TREASURER'S REPORT

PERIOD COVERING 11/1/1984 TO 10/31/1985

Balance Beginning of Period	\$5074.37
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INCOME

Dues	1985	Regular	165 @ 7.50	1237.50		
		Family	25 @ 1.00	25.00		
		Student	13 @ 3.00	39.00	1301.50	
	1983-84-86	Regular	3 @ 7.50	22.50	22.50	1324.00

PUBLICATIONS

Vol. 1-16 & OP#2 (two ea.)	91.25
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A/A INTEREST 10/31/84 TO 9/30/1985	299.07	299.07
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STUDENT GRANT FUND	290.50	290.50
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AUCTION	1319.90	1319.90
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PRE-REGISTRATION FEES	4555.50
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Conference Fees	3165.05	7720.55	9728.77
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Income	16127.14
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Expenses	10628.05
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Balance	5499.09
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EXPENSES - PERIOD COVERING 11/1/1984 to 10/31/1985

Treasurer	331.21	
President	287.80	
Secretary (Paul Scott)	58.24	**
Secretary of State	2.50	
COA dues	7.50	
AMU dues	22.00	
Purchase of copies of Vol. 4 & OP#1 from S. Long	148.00	
Vida Kenk (S. Grant Notices)	125.48	
Membership refund (2yr., Purdue)	15.00	
Annual Report	1422.47	
Historian's Book	45.88	
U.C. Regents - Conference fees	650.00	
	265.00	
	1602.02	**
	4591.20	
Services of Tom Khenery	50.00	
dredging trip	625.00	
Refund - overpayment of Conference fees		
Carr	\$120.00	
Bratcher	24.00	
Burch	55.50	
Christensen	15.00	
Corey	5.00	
Hansen	50.50	
Dilworth	20.00	
Keeler	40.00	
Poorman	40.00	
	Total	10628.05
** Checks outstanding 10/31/1985		

Auditing Committee	Margaret Mulliner, Treas.
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Jules Hertz

Carole Hertz

David Mulliner



List of People in Group Photo

Front Row (left to right): Edna Naranjo, Richard Reeder, Walter B. Miller, David K. Mulliner, Bert C. Draper, Twila Bratcher, Richard Squires, Lou Ella Saul, Richard B. Saul, Walter E. Carr, Tom Burch, Bill Pitt, Sandy Gardner

2nd Row: Paul Scott, Betty Sue Miller, Tris Harman, Carol Skoglund, Jack W. Brookshire, Carole M. Hertz, Jules Hertz, Ronald G. Velarde, Don Shasky, Kathy McMorran, Charlotte Norrid, Hal Norrid, Rose Burch, Floyd Gardner, Bev Hansen

3rd Row: Jody Woolsey, Hans Bertsch, Sandra Millen, Roland Anderson, Matthew Joseph James, Timothy Allen Pearce, Terrence Milton Gosliner, Patrick Ives LaFollette, James H. McLean, Paul E. Skoglund, Kirstie Kaiser, Lois Pitt, Margaret Mulliner, Edith Abbott, Rosemary Adams, George Kennedy, Alan Hebert.

Executive Board and Committee Members 1984-1985

OFFICERS & EXECUTIVE BOARD

President - Terrence M. Gosliner
1st Vice President - Carole Hertz
2nd Vice President - Matthew J. James
Secretary - F. G. Hochberg
Treasurer - Margaret Mulliner

Members-at-Large
Kirstie Kaiser, Paul Scott

Three most recent past Presidents
William Pitt - George L. Kennedy - David R. Lindberg

Mentor-Parliamentarian - Eugene V. Coan

STANDING COMMITTEES

Auditing
Jules Hertz* - Carole Hertz - David Mulliner
Nominating
William Pitt* - George L. Kennedy - David R. Lindberg

Editorial Board
Steven J. Long - Editor
Hans Bertsch - Eugene V. Coan
Terrence M. Gosliner - George L. Kennedy - Barry Roth

Historian - Jody Woolsey
Registration - Margaret Mulliner

Student Awards
Vida C. Kenk*
Eugene V. Coan - James W. Nybakken
Barry Roth - Judith Terry Smith

* (indicates chairperson)

Western Shell Clubs

Chico Seashell Club

c/o Phyllis Slattery, Sec.
106 Terrace Drive
Chico, CA 95926

[meets twice a month, 2nd Wed. 9:30 am in member's homes, and 4th Wed. 7:30 pm at Pleasant Valley Recreation Center, North Avenue, Chico, CA]

Conchological Club of Southern California

c/o Malacology Section
Los Angeles County Museum of Natural History

900 Exposition Boulevard
Los Angeles, CA 90007

[meets in Museum Lounge, 7:30 pm, first Monday of each month, unless a holiday, then on Wednesday of same week]

Hawaiian Malacological Society

P.O. Box 10391
Honolulu, HI 96816

[meets first Wednesday of each month, 7:00 pm, at First United Methodist Church, Victoria & Beretania Streets, Honolulu; December party at another location]

Houston Conchological Society

c/o Constance Boone
3706 Rice Boulevard
Houston, TX 77005

[meets fourth Wednesday of August, September, October, January, February, March, April, and May; third Wednesday of November, at the Houston Museum of Natural Science]

Monterey Peninsula Shell Club

[meets at the Allen Knight Maritime Museum, 550 Calle Principal, Monterey, California, on the third Tuesday of each month at 7:30 pm. Programs and local collecting trips are planned monthly]

Northern California Malacozoological Club

121 Wild Horse Valley Drive
Novato, CA 94947

[meets third Thursday of each month at the California Academy of Sciences]

Oregon Society of Conchologists

Dr. Byron W. Travis
4324 NE 47th Avenue
Portland, OR 97218

[meets first Sunday of each month, 1:30 pm, in private homes; announcements given in monthly paper or by card]

Pacific Northwest Shell Club, Inc.

c/o 15128 Sunwood Blvd.
Tukwila, WA 98188

Pacific Shell Club

c/o John Boyd
11813 Morning Ave.
Downey, CA 90241

[meets in Museum Lounge first Sunday of each month, 1:30 pm, October through June]

San Diego Shell Club

c/o 3883 Mt. Blackburn Avenue
San Diego, CA 92111

[meets third Thursday of every month, Casa del Prado, Balboa Park]

Santa Barbara Malacological Society

P.O. Box 30191
Santa Barbara, CA 93105

[meets third Friday of every month, 7:30 pm, Santa Barbara Museum of Natural History, 2559 Puesta del Sol]

Southwestern Malacological Society

c/o Mrs. Carol C. Skoglund
3846 E. Highland Avenue
Phoenix, AZ 85015

[meets third Wednesdays, September through May, 7:30 pm, Asbury United Methodist Church, 1601 W. Indian School Road, in auxiliary rooms]

Yucaipa Shell Club

c/o Mousley Museum of Natural History
35308 Panorama Drive
Yucaipa, CA 92399

[meets third Sunday of every month except August, 2:00 pm, in the museum]

Membership Directory

- Abbott, Dr. R. Tucker, P.O. Box 2255, Melbourne, FL 32902-2255
 Abbott, Mrs. Keith (Edith M.), 1264 W. Cienega Avenue, San Dimas, CA 91773
 Academy of Natural Sciences, The Library, Nineteenth & The Parkway, Philadelphia, PA 19103
 Adams, Mr. Elmo W., 747 Winchester Drive, Burlingame, CA 94010
 Adams, Ms. Catherine R., 13346 Birchwood Drive, Sunnymead, CA 92388
 Alan Hancock Foundation, Hancock Library, University of Southern California, University Park, Los Angeles, CA 90007
 American Geological Institute, The Library, 4220 King St., Alexandria, VA 22302
 American Malacological Union, Inc., 7602 McCullough Avenue, San Antonio, TX 78216
 American Museum of Natural History, Serials Unit, Library, Central Park West at 79th Street, New York, NY 10024
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 Arizona State University, The Library, Department of Zoology, Tempe, AZ 85281
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 Australian Museum, The Library, Box A285, Sydney, South, N.S.W., Australia 2000
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 Everson, Mr. Gene D., 5203 Court View Dr., Charlotte, NC 28226
 Fahy, Neil E. & Claire L., 1425 Mayfair Ave., Daly City, CA 94015

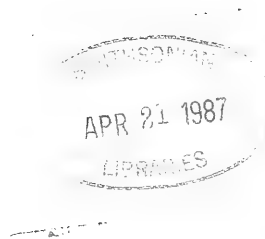
- Farmer, Dr. Wesley M. & Barbara, 11061 Lea Terrace Drive, Santee, CA 92071
- Ferguson, Mr. Ralph E., 617 N Fires Avenue, Wilmington, CA 90744
- Ferreira, Dr. Antonio J., 2060 Clarmar Way, San Jose, CA 95128
- Field Museum of Natural History, Library - Serials, Roosevelt Road at Lake Shore Drive, Chicago, IL 60605-2498
- Fisheries Canada, Pacific Biological Station, Nanaimo, British Columbia, Canada V9R 5K6
- Forrer, Mr. Richard B., P.O. Box 462, Northfield, OH 44067
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- Friday Harbor Laboratory, The Library, Friday Harbor, WA 98250
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- Hopkins Marine Station, The Library, Stanford University, Pacific Grove, CA 93950
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- Institut Royal des Sciences Naturelles, de Belgique, Rue Vautier 31, 1040 Bruxelles, Belgium
- Institute of Geology and Paleontology, Library, Faculty of Science, Tohoku University, Sendai, Japan
- Israel Malacological Society, c/o Dr. H.K. Mienis, Department of Zoology, Hebrew University of Jerusalem, Jerusalem, Israel
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- Knight, Ms. Lori B., Rt. 2, Box 112, Caldwell, ID 83605
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- Librairie Justus Lipsius, SC-AV Milcamps 188-B 15, 1040 Bruxelles, Belgium
- Library of Congress, Exchange and Gift Division, Washington, DC 20540
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- Lindberg, Dr. David R., Museum of Paleontology, University of California, Berkeley, CA 94720
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- Malacological Society of China, c/o Taiwan Museum, Taipei, Taiwan, Republic of China
- Marelli, Dan C., 5812 - 16th Lane S #2, St Petersburg, FL 33712
- Marinovich, Dr. Louie, Jr., Paleontology & Stratigraphy, U.S. Geological Survey MS-15, 345 Middlefield Road, Menlo Park, CA 94025
- Marine Biological Laboratory, The Library, Woods Hole Oceanographic Institution, Woods Hole, MA 02543
- Marine Science Center Library, Oregon State University, Marine Science Drive, Newport, OR 97365
- Martin, Mr. Clifford A., 324 Kennedy Lane, Oceanside, CA 92054
- Martin, Mr. Clifton L., 324 Kennedy Lane, Oceanside, CA 92054

- Mastro, Mr. Edwin, 1021 Grand Avenue, Long Beach, CA 90804
 Matra Museum, H-3201 Gyongyos, P.O. Box 103, Hungary
 McGill University Libraries, Acquisitions Department, 3459 McTavish Street, Montreal, Quebec, Canada H3A 1Y1
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 Metcalf, Dr. Artie L., Department of Biological Science, University of Texas, El Paso, TX 79968
 Metz, Dr. George, 121 Wild Horse Valley Drive, Novato, CA 94947
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 Miller, Dr. Walter B., 6140 Cerrada El Ocote, Tucson, AZ 85718
 Moore, Ellen J., U.S. Geological Survey (MS-915), 345 Middlefield Road, Menlo Park, CA 94025
 Moore, Mr. & Mrs. Eric (Eileen), P.O. Box 6606, Orange, CA 92667
 Moss Landing Marine Laboratories, The Library, P.O. Box 450, Moss Landing, CA 95039-0223
 Mulliner, Mr. & Mrs. David K. (Margaret), 5283 Vickie Drive, San Diego, CA 92109
 Murray, Dr. Harold D., Biology Department, Trinity University, San Antonio, TX 78284
 Museum Der Naturkunde, Invalidenstrasse 43, 104 Berlin 4, Berlin, Deutsch Demokratische Republik
 Museum National d'Histoire Naturelle, Laboratoire de Biologie des Invertébrés, Marins et Malacologie, 55 Rue de Buffon, 78 Paris 5 France
 Museum d'Histoire Naturelle, Bibliotheque, Route de Malagnou, Case Postale 434, CH-1211 Geneve 6, Switzerland
 Museum of Zoology, Mollusk Division, University of Michigan, Ann Arbor, MI 48104
 Myers, David, 109 Behr Ave., San Francisco, CA 94131
 Naranjo-Garcia, Edna, 3814 E. 4th St. #108, Tucson, AZ 85716
 Natal Museum, 237 Loop Street, Pietermaritzburg 3201, Natal, South Africa
 National Academy of Sciences, Malacological Committee, Universitetskaya Naberezhnaya I, Leningrad, USSR B-164
 National Museum of Canada, The Library, Ottawa, Ontario K1A 0M8, Canada
 National Museum of New Zealand, Librarian, (STC 327) Private Bag, Wellington C3, New Zealand
 National Museum of Victoria, 285-321 Russell Street, Melbourne, Victoria 3000, Australia
 National Science Museum, Malacology, Hyakunin-cho, Shinjuku-ku, Tokyo 160, Japan
 Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, CA 90007
 Naturhistorisches Museum, Wien, 3. Zoologische Abteilung, Postfach 417 Burging 7, A-1014 Wien, Austria
 Naturhistorisches Museum, Rutjmeyer-Bibliothek, Augustinergasse 2, CH-4001 Basel, Switzerland
 Neiswander, Mrs. Gordon (Marjorie), 1340 New York Drive, Altadena, CA 91001
 Netherlands Malacological Society, c/o Zoological Museum, Postbox 20125, Amsterdam 1000HC, Netherlands
 New Zealand Geological Survey, Librarian, Central Library, DSIR, P.O. Box 30368, Lower Hutt, New Zealand
 New Zealand Oceanographic Institute, The Librarian, P.O. Box 12-346, Wellington, New Zealand
 Niesen, Dr. Thomas M., Department of Biology, San Francisco State University, 1600 Holloway Avenue, San Francisco, CA 94132
 Norrid, Mr. & Mrs. Harold (Charlotte), 233 E. Cairo Drive, Tempe, AZ 85282
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 Nybakken, Dr. James W., Moss Landing Marine Laboratories, Moss Landing, CA 95039-0223
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THE WESTERN SOCIETY OF MALACOLOGISTS

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Monterey, California
1 - 6 July 1986



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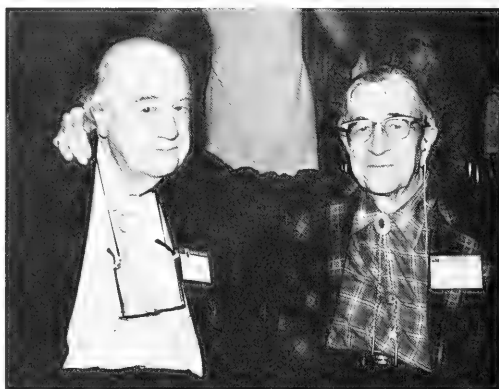
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A. MYRA KEEN & S. STILLMAN BERRY

Photos by James H. McLean

It is with profound gratitude for her
major contributions to malacology,
and with a feeling of fond affection,
that we dedicate this issue of the
Western Society of Malacologists, Annual Report,
to Dr. A. Myra Keen



A. Myra Keen & Joshua L. Baily, J.L. Baily and S.S. Berry

Photos by David K. Mulliner

A. MYRA KEEN, 1905-1986: A TRIBUTE

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In 1955, Myra Keen wrote Henry Pilsbry about a nomenclatural problem in the gastropod family Trochidae, concerning something he had done in his *Manual*. In reply, Pilsbry said, "It is over sixty years since I wrote that *Manual of Conchology* review of the group. This was so long before they bought a high chair for you that you can hardly appreciate the fact that in 1890 there was no official or even customary method of selecting type species. . . . Those were dark but carefree days. We little knew of the brambles and pitfalls concealed in the thickets of nomenclature we have to fight our way through nowadays."

Few workers have made as much headway as did Myra Keen in clearing away the brambles and filling in the nomenclatural pitfalls. It became her forte.

Angeline Myra Keen was born May 23, 1905, in Colorado Springs, Colorado. (She never liked her first name, and as the years went by, her name evolved to A. Myra Keen and finally to just Myra Keen.) An only child, her family lived on a ranch of 1,200 acres situated 20 miles south of town. She attended a one-room school, and went through eight grades in five years. As a result, she was out of school and on the ranch for three years, riding horses and herding cattle. She then had ambitions of becoming a rodeo queen!

She went to high school in Colorado Springs, where she graduated in 1923. Then followed more years in the country, during which she became interested in nature photography. Several of her pictures and an article were published in photography journals.

Her family then moved back into Colorado Springs. There, her father started a chicken farm and also earned money by landscape gardening. Here, Myra attended Colorado College, with the intent of majoring in biology. Unfortunately, distaste for having to dissect a cat and her shock at finding insects awakening on pins in her collection turned her from biology to psychology. She graduated Phi Beta Kappa in 1930.

Myra and her mother came to California to allow her to attend graduate school at Stanford University, and she received a master's degree there in 1931. She next attended the University of California at Berkeley, where she earned her PhD in 1934 with a thesis project on the reasoning of children. It was never published. She said that her father's "chicken money" had put her through college.

After graduation, she found that it wasn't that easy to find a job in psychology, so she was out of work. During a stay at Monterey, Myra picked up

some shells on the beach. Later, she visited a hobby shop in Berkeley that sold shells along with coins, stamps and used books, and she got a little information about her beach finds. Nettie Falkenthal, a Monterey collector, told her about Mrs. Ida Oldroyd, who had become established with her collection in the Geology Department at Stanford University and later introduced the two. Still without employment but with a home base in Palo Alto, she became a volunteer at Stanford, helping Mrs. Oldroyd with her collection and that of Henry Hemphill, which had been acquired by Stanford several years earlier. She didn't get along with Mrs. Oldroyd very well, and her loyalties gravitated to Stanford Geology Prof. Hubert Schenck, who introduced her to the fossil faunas of the Pacific Coast. She began to audit geology and paleontology courses. After two years as an unpaid volunteer, she was appointed Curator of Paleontology.

Schenck encouraged her to apply the skills she had gained in statistics (during her work in psychology) to the distribution of Recent and fossil faunas. Two key papers resulted that analyzed fossil faunas based on the distributions of Recent taxa.

During World War II, Schenck went into the Army, and Dr. Keen started teaching courses at Stanford in historical geology and paleontology. This opened a career path, and without formal post-graduate training in geology or paleontology, and in spite of being a woman in a male-dominated environment, she was named Assistant Professor of Paleontology in 1954, Associate Professor in 1960, and full Professor in 1965.

In addition to her work with Prof. Schenck on statistical biogeography, her other important early papers concerned the Miocene fossils of the southern Central Valley in California, and nomenclatural questions.

Major influences on her approach to malacology in addition to Schenck were Emery and Elsie Chace, John and Rose Burch, Fred Baker, Paul Bartsch, and Junius Henderson.

A key turning point was reached when a wealthy collector from southern California decided to fund a book on the fauna of the Panamic province. The project began with a committee, but soon Myra Keen was on her own. The result was the 1958 edition of *Sea Shells of Tropical West America*. A second, much larger and enhanced edition was published in 1971.

She never did extensive collecting herself. Noteworthy trips include one up the Pacific Coast in 1935, collecting every 100 miles or so to further her bio-

geographic studies; to southern California two years later; and to the Gulf of California on several occasions starting in 1941. She also traveled to Europe four times, in search of type specimens of eastern Pacific species, visiting marine stations to compile information for her course in biological oceanography, or attending meetings.

Her key accomplishments were of three sorts. The first involved major compilations that stimulated much other work and public interest. In addition to the two editions of the *Sea Shells of Tropical West America*, these included her work with Herdis Bentson listing all the records of Tertiary species in California; her field guide with Hubert Schenck to California Tertiary fossils; the keys to the molluscan genera of the northeastern Pacific; and her bibliography and checklist of the fauna of the northeastern Pacific.

The second main focus of her publications was the nomenclatural revisions she prepared for the *Treatise on Invertebrate Paleontology*, together with many related petitions to the International Commission on Zoological Nomenclature. These revisions included many on groups of bivalves and archaeogastropods in addition to those of special interest to her. Unfortunately, her extensive work on mesogastropods and neogastropods for the *Treatise*, the Nassariidae, and the Assmineidae, resulting in substantial manuscripts, now seems destined never to be published. Also belonging in this category are her papers on the type specimens of eastern Pacific species in European museums.

Her third focus was taxonomic publications in various journal and museum serials on groups such as the Vermetidae, the Muricidae, the Cardiidae, the Veneridae, and the Sacoglossa.

Myra Keen was AMU President in 1948, AMU Pacific Division Chairman in 1964, WSM President in 1970, a Fellow of the California Academy of Sciences and of the Geological Society of America, chairman of the Nomenclature Committee of the Society of Systematic Zoology, and recipient of a Guggenheim Fellowship to facilitate her work in Europe.

Her students included Carole Hickman, Judy Smith, James McLean, Robert Robertson, and me.

In other aspects of her life, she was a deeply religious Quaker, enjoyed classical music, read widely on a variety of subjects, and carried on unusually extensive correspondence, both in her field and with friends and others.

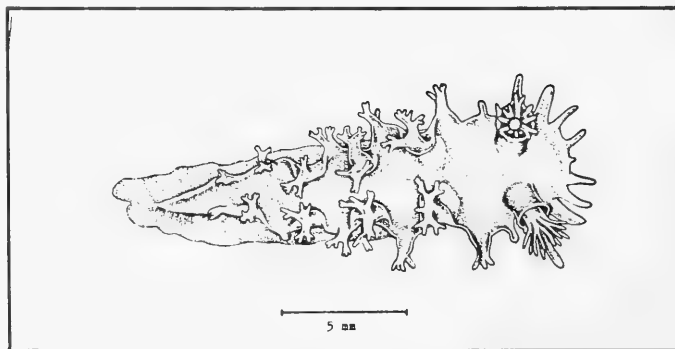
In describing the highlights of her career, she pointed to her discovery of the first known bivalved gastropod in the eastern Pacific and her personal audience with Emperor Hirohito during his visit to San Francisco in 1975.

A full biography, bibliography, and list of taxa will appear in a forthcoming issue of *Malacologia*. The bibliography, which I prepared, lists 281 titles in malacology. These include everything from abstracts and book reviews (both of which sometimes contain original taxonomic points) to the entire archaeogastropod volume of the *Treatise*. She described 93 taxa, including a number of family-group names.

In spite of the fact that her nomenclatural work was exhaustive and precise, she never made a complete list of her own publications or taxa. She was too modest, I expect. In any event, this made preparing a bibliography and taxonomic list far more difficult and time-consuming than it ought to have been.

Her own small collection, made before she received a formal appointment at Stanford, is now at the Santa Barbara Museum of Natural History. The Stanford University Collection is now on permanent loan to the California Academy of Sciences. Remaining at Stanford is the Myra Keen Exhibit of Modern and Fossil Shells. Her scientific correspondence and notes are in the Smithsonian Archives. Reprints of many of her own papers are still available through the Mollusk Division at the National Museum of Natural History.

Myra Keen will remain with us over the years and decades -- as we use her many publications and as we remember her quiet, unassuming way of shaping our field, our institutions, and our work.



Tritonia myrakeenae Bertsch & Mozqueira, 1986

THE HETEROPOD FAUNA OF OCEANIC WATERS OFF HAWAII

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ABSTRACT

A diverse heteropod fauna occurs in the oceanic waters off Oahu, Hawaii. All three families of the Heteropoda, the Atlantidae, Carinariidae and Pterotracheidae, are present. Among the Atlantidae the two monospecific genera *Oxygyrus* and *Protatlanta* are represented along with eight species of the genus *Atlanta*. Two genera of carinariids occur, *Pterosoma* and *Carinaria*, the first of which is monospecific while the second includes three species. The Pterotracheidae include the monotypic genus *Firoloida* and three species of *Pterotrachea*. The families are characterized and keys are given to the species recorded from trawl and net samples collected over a seven-year period off the leeward side of the island of Oahu.

INTRODUCTION

The heteropods are an unusual group of carnivorous gastropods (Prosobranchia: Mesogastropoda) that are holopelagic and are found primarily in shallow waters (upper 150m of the water column) of tropical to subtropical regions of the world's oceans. The general biology of the group was summarized by Thiriot-Quievreux (1973) and their taxonomy reviewed by Tesch (1949) and updated by van der Spoel (1976). The highly modified morphologies of the heteropods illustrate a series of special adaptations to their open ocean, holopelagic existence. Of the three families in the superfamily Heteropoda the Atlantidae are the least modified, possessing a laterally-compressed shell into which the body can be retracted and closed off by an operculum. Atlantids are quite small, reaching a maximum shell length of about 10mm, although most Hawaiian specimens range from the metamorphosed size of about 0.6mm to about 4mm. Like the other two families, the atlantids have a flattened fin-like foot used for swimming and well developed image-forming eyes for prey location (see Fig. 1). A taenioglossan radula with modified spine-like marginal teeth is used in prey capture. The diet of one species of atlantid, *Oxygyrus keraudreni*, from the tropical Atlantic Ocean off west Africa was found (Richter, 1982) to consist mainly of thecosomatous pteropods, heteropods and copepods. Among the carinariids the food habits of only one species, *Carinaria japonica*, have been examined in detail (Seapy, 1980). Off southern California, this species was found to consume a wide variety of zooplankton, although salps, doliolids and chaetognaths were preferentially fed upon. The feeding habits of the pterotracheids are unknown.

In the carinariids (Figs. 12 and 14) and pterotracheids (Figs. 18 and 19) the body is markedly different in structure from that of the atlantids, becoming greatly enlarged, generally with an elongate cylindrical body that is transparent and muscular. The cylindrical body axis contains a large hemocoel. This fluid-filled space undoubtedly functions in both groups as a buoyancy mechanism by

the partial exclusion of sulphate ions, as Denton and Shaw (1961) showed for *Pterotrachea coronata*. In the carinariids only the gills and portions of the digestive and reproductive systems (i.e., the visceral mass) are protected beneath a reduced cap-shaped shell of varied shape. In the pterotracheids the shell is lacking altogether and the visceral mass is further compacted into a tear-drop shaped structure termed the visceral nucleus. By swimming upside down and maintaining the narrow and elongate visceral nucleus in a vertical orientation (see Fig. 19), the nucleus projects a minimal silhouette downward in the water column; an adaptation against upward-searching predators (Seapy and Young, 1986).

All three families of heteropods are represented in Hawaiian waters and will be dealt with individually below. The families can be distinguished by the presence (Atlantidae and Carinariidae) or absence (Pterotracheidae) of the calcareous shell. As indicated above, the atlantids are small and the animal can retract into the laterally-compressed shell, while the carinariids are large and gelatinous with the shell confined to a small area covering the visceral mass.

ATLANTIDAE

The atlantids are the most abundant heteropods in the Hawaiian fauna. All three of the recognized genera (*Oxygyrus*, *Protatlanta* and *Atlanta*) are represented. Of the fourteen species of *Atlanta* reported from the Pacific Ocean (van der Spoel, 1976), eight occur off Hawaii. It is noteworthy that the eight species I recorded were those recognized from the Pacific Ocean by Tesch (1949), while the other six species have been described since 1954 and I have found no evidence of their occurrences off Hawaii. The following preliminary key should work to separate the eight species. To use the key the shell should be oriented on its side, with the right side (and thus the shell spire) toward the viewer. Viewing the shell from the left side, the inner whorls spiral inward forming an umbilicus. All measurements of shell length exclude the keel, which can be broken off along the posterior margin of the shell.

KEY TO THE ATLANTIDAE OFF HAWAII

- 1 a. Inner whorls of shell depressed; projecting right-handed spire lacking. Both shell and well-developed keel are cartilaginous *Oxygyrus keraudreni* (Fig. 2)
- b. Inner whorls of shell extend outward from right side to varying degrees, forming projecting spire. Although keel may be cartilaginous, shell is not 2
- 2 a. Prominent keel cartilaginous and transparent (can only be viewed using oblique, reflected lighting), extending to edge of shell aperture *Protatlanta souleyeti* (Fig. 3)
- b. Keel not cartilaginous or transparent, tapering gradually to shell aperture .. (genus *Atlanta*) 3
- 3 a. Unpigmented shell consists of three whorls, third whorl greatly expanded *A. lesueuri* (Fig. 4)
- b. Shell consists of four or more whorls 4
- 4 a. Spire tilted (or inclined) relative to plane of last (or outer) whorl *A. inclinata* (Fig. 5)
- b. Spire not tilted, projecting outward at right angle to last body whorl 5
- 5 a. Viewed dorsally, shell compressed, width approximately 25% of length. Inner whorls smooth, lacking spiral sculpture 6
- b. Shell somewhat inflated, width about 40% of length. Inner whorls possess spiral sculpture, developed to varied degrees 7
- 6 a. Sutures of inner whorls unpigmented to light pink; length of last whorl at shell aperture less than 45% of total shell length *A. peroni* (Fig. 6)
- b. Sutures of inner whorls purple-pink to maroon-pink in color; shell aperture broader than in preceding species (greater than 45% of total shell length) *A. gaudichaudi* (Fig. 7)
- 7 a. Spire steeply sloped, projecting strongly from plane of last shell whorl 8
- b. Spire relatively flat, does not project strongly beyond plane of last shell whorl 9
- 8 a. Spire turreted, steeply sloping (spire angle about 35 - 45°); shell clear to light reddish brown in color *A. turriculata* (Fig. 8)
- b. Spire not steeply sloping (spire angle about 65 - 70°); shell distinctive dark golden brown color *A. fusca* (Fig. 9)
- 9 a. Sutures of inner whorls incised and distinct, purplish pink in color; digestive gland lacks pigmentation; keel low ... *A. helicinoides* (Fig. 10)
- b. Inner whorls weakly separated by shallow sutures, which lack coloration; inner whorls further obscured by well-developed spiral sculpture; digestive gland with mottled to hashed pattern of reddish-purple to reddish-brown color; keel high *A. inflata* (Fig. 11)

CARINARIIDAE

Three genera of carinariids are recognized, two of which, *Pterosoma* (Fig. 12) and *Carinaria* (Fig. 14),

occur in Hawaiian waters. The third genus, *Cardi-poda*, is represented by two species that co-occur in their distribution and have only been recorded from the eastern and western portions of the tropical and subtropical Pacific Ocean (van der Spoel, 1976). Off Oahu three species of *Carinaria* and one species of *Pterosoma* are collected infrequently in trawl samples. Major anatomical structures are indicated in the figures of each genus (Figs. 12 and 14). Two of the species of *Carinaria* treated here, *C. japonica* and *C. lamarcki*, are designated by van der Spoel (1976) as "formae," i.e., as *C. cristata* forma *japonica* and *C. lamarcki* forma *lamarcki*. I have chosen not to follow van der Spoel, but rather to treat these as distinct species. In both cases, the "formae" of each species are sympatric (shown in the distributional charts of van der Spoel, 1976), and justification for their recognition as separate "formae" seems inappropriate. The following key separates the four species collected from waters off Oahu.

KEY TO THE CARINARIIDAE OFF HAWAII

- 1 a. Shell dorso-ventrally flattened, forming broad cap over visceral mass, which in turn is situated in a depression on the dorsal surface of the gelatinous, disc-shaped body *Pterosoma planum* (Figs. 12 and 13)
- b. Shell tall (height about equal to or greater than width) and encloses visceral mass, which in turn is situated on a dorsal stalk, resulting in elevation of visceral mass above the cylindrical, gelatinous body (genus *Carinaria*; Figs. 14-17) . . 2
- 2 a. Shell height about one-half of shell length; apex posterior *C. lamarcki* (Fig. 15)
- b. Shell height equal to or greater than shell length; apex dorsal 3
- 3 a. Keel of shell low; posterior tail well developed, with prominent dorsal crest *C. japonica* (Fig. 16)
- b. Keel of shell high; posterior tail small, lacking prominent dorsal crest *C. galea* (Fig. 17)

PTEROTRACHEIDAE

Next to the atlantids, the pterotracheids are the most frequently collected heteropods in the Hawaiian fauna. They are abundant in open trawl samples, but usually are collected in small numbers in plankton net samples. The two genera of pterotracheids, *Firolloida* and *Pterotrachea*, are present. In a recent taxonomic review of the genus *Pterotrachea* from Hawaiian waters, Seapy (1985) reported that while two of the species, *P. coronata* and *P. scutata* were distinctive, specimens that could be assigned to the species *P. minuta* appeared to be young individuals of the species *P. hippocampus*. Morphological features of the pterotracheids are shown for *F. desmaresti* (Fig. 18) and *P. hippocampus* (Fig. 19). Because the differences in *Pterotrachea* are illus-

trated in Seapy (1985), sketches of the different species are not included here. The following key (based on Seapy, 1985:133) separates the four species of pterotracheids occurring in Hawaiian waters.

KEY TO THE PTEROTRACHEIDAE OFF HAWAII

- 1 a. Tail absent posterior to visceral nucleus; tentacles anterior to eyes present in males *Firoloida desmaresti* (Fig. 18)
- b. Tail present posterior to visceral nucleus; tentacles anterior to eyes absent (genus *Pterotrachea*; Fig. 19) . . 2
- 2 a. Eyes narrowly triangular (small individuals) to broadly rectangular (large individuals) in dorsal view; eye length less than 1.6 times width of retinal base *P. hippocampus*
- b. Eyes rectangular in dorsal view; eye length greater than 1.8 times width of retinal base . . 3
- 3 a. Visceral nucleus short (length two to four times maximal width); anterior portion of body expanded laterally as gelatinous disc *P. scutata*
- b. Visceral nucleus elongate (length four to seven times maximal width); anterior portion of body not expanded laterally as gelatinous disc *P. coronata*

CHECK LIST OF HAWAIIAN HETEROPODA

- Family Atlantidae Wiegmann & Ruthe, 1832
 Genus *Oxygyrus* Benson, 1835
Oxygyrus keraudreni (Lesueur, 1817)
 Genus *Protatlanta* Tesch, 1908
Protatlanta souleyeti Smith, 1888
 Genus *Atlanta* Lesueur, 1817
Atlanta fusca Souleyet, 1852
Atlanta gaudichaudi Souleyet, 1852
Atlanta helicinoides Souleyet, 1852
Atlanta inclinata Souleyet, 1852
Atlanta inflata Souleyet, 1852
Atlanta lesueurii Souleyet, 1852
Atlanta peroni Lesueur, 1817
Atlanta turriculata d'Orbigny, 1836
 Family Carinariidae Fischer, 1883
 Genus *Carinaria* Lamarck, 1801
Carinaria galea Benson, 1835
Carinaria japonica Okutani, 1955
Carinaria lamarcki Peron & Lesueur, 1810
 Genus *Pterosoma* Lesson, 1827
Pterosoma planum Lesson, 1827
 Family Pterotracheidae Gray, 1843
 Genus *Pterotrachea* Niebuhr (ms. Forskal), 1775
Pterotrachea coronata Niebuhr (ms. Forskal), 1775
Pterotrachea hippocampus Philippi, 1836
Pterotrachea scutata Gegenbaur, 1855

ADDENDUM

During a cruise aboard the R/V KELA in November 1986, an additional species of *Atlanta* was collected in low abundance from a series of shallow (0 - 50 m) tows made with 1 m² and 4 m² plankton nets. The species appears to be *Atlanta echinogyra* Richter, 1972. It is a small animal (shell length less than 2 mm) and is characterized by a moderately elevated spire consisting of three distinctive reddish-brown whorls with spiral sculpture. The outermost shell whorl is unpigmented and lacks the spiral sculpture of the inner whorls.

ACKNOWLEDGEMENTS

This paper is based on collected specimens and photographs of live animals taken during seven cruises on the University of Hawaii's oceanographic ships R/V KANA KEOKI (between 1980 and 1984) and R/V KELA (1985 and 1986) off the leeward side of the island of Oahu. The cruises were part of the on-going research program of Dr. Richard E. Young, Department of Oceanography, University of Hawaii. My gratitude is expressed to Dr. F. G. Hochberg for review of the manuscript and assistance assembling the illustrations. Figure 19 was modified from a drawing (in Seapy, 1985) by Ms. Laurie Marx. This work was supported by National Science Foundation Grant OCE-8500593.

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FIGURE LEGENDS

Figures 1-11. Family Atlantidae. Scale below Fig. 5 applies to Figs. 3-11.

Fig. 1. Lateral view of *Protatlanta souleyeti* with body extended from shell (drawing based on photograph of live animal). BM = buccal masse, E = eye, ES = esophagus, F = foot, K = keel, O = operculum and S = sucker.

Fig. 2. Shell of *Oxygyrus keraudreni*

Fig. 3. Shell of *Protatlanta souleyeti*

Figs. 4 - 11. Shells of *Atlanta*. (4) *A. lesueuri*; (5) *A. inclinata*; (6) *A. peroni*; (7) *A. gaudichaudi*; (8 A,B) *A. turriculata*; (9 A,B) *A. fusca*; (10) *A. helicoides*; (11) *A. inflata*.

Figures 12 - 17. Family Carinariidae. Scale between Figs. 15 and 16 also applies to Fig. 17.

Fig. 12. Dorso-lateral view of a female *Pterosoma planum* (drawing based on photograph of live animal in an aquarium).

Fig. 13. Dorsal view of shell of *P. planum*.

Fig. 14. Lateral view of a male *Carinaria japonica* (drawing based on photograph of live animal in an aquarium).

Figs. 15 - 17. Shells of *Carinaria*. (15) *C. lamarki*; (16) *C. japonica*; (17) *C. galea*.

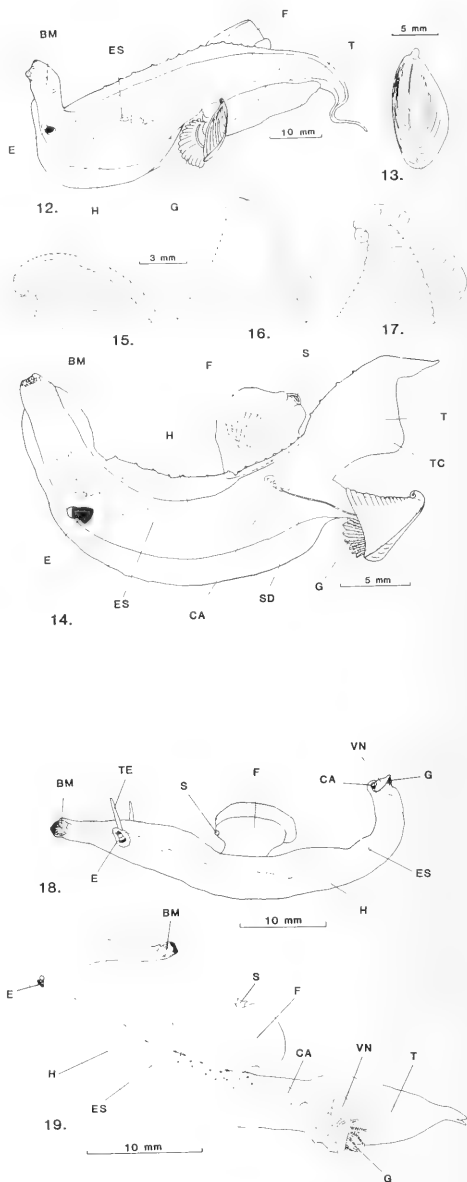
BM = buccal mass, CA = copulatory apparatus, E = eye, ES = esophagus, F = foot, G = gills, H = hemocoel, S = sucker, SD = sperm duct, T = tail, TC = tail crest.

Figures 18 - 19. Family Pterotracheidae.

Fig. 18. Lateral view of a male *Firoloida desmaresti* (drawing based on preserved specimen).

Fig. 19. Lateral view of a male *Pterotrachea hippocampus* (drawing based on photograph of live animal in an aquarium; after Seapy, 1985).

BM = buccal mass, CA = copulatory apparatus, E = eye, ES = esophagus, F = foot, G = gills, H = hemocoel, S = sucker, T = tail, TE = tentacle, VN = visceral nucleolus.



A PRELIMINARY REVIEW OF
MYSELLA (BIVALVIA, MONTACUTIDAE)
FROM THE NORTHWESTERN PACIFIC

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Members of the genus *Mysella* Angas, 1877, are small featureless bivalves, possessing only limited sculpture externally. Two species in the northeast Pacific attain a length of about 10 mm, while all others are under 5 mm. Conchologically the genus is characterized by the presence of two diverging cardinal teeth in the left valve, and the absence of cardinal teeth in the right valve. The right valve in most species has lateral teeth which interlock in grooves on either side of the cardinal teeth in the left valve. The ligament is internal, seated in a deep resilifer, directly below the beaks.

Mysella species are a common component of the infauna from Alaska to the equator, frequently reaching densities in excess of 100/m². Members of the genus have been observed as free-living or associated with a variety of burrowing invertebrate hosts. In the Pacific Northwest intertidal, *Mysella tumida* (Carpenter, 1864) has been observed by D.O. Foighil (pers. comm.) in association with polychaetes and holothuroids. In addition, *Mysella pedroana* Dall, 1899, a southern California species, has been found attached by a byssus to the gills of mole crabs.

While the biology of several *Mysella* species is becoming increasingly well understood, the taxonomy of northeastern Pacific species is extremely confused. This confusion is primarily due to three factors: 1) all species are small and superficially featureless; 2) many species are known only from badly damaged type specimens or sketches of juvenile shells (in some cases the type specimen is an edentulous right valve); 3) the shells of several species appear to be exceedingly plastic.

Fourteen species of *Mysella* have been described from the northeast Pacific Ocean. Of these, eight appear to be valid, and the other six are junior synonyms. In addition, I have observed 4 potentially new species.

The most common species is *Mysella tumida*. The type specimen is robust, with strong cardinal teeth. The beaks are anteriorly placed with a truncate anterior margin. The species is distributed from the Alaskan arctic to San Diego, California, at intertidal depths to 120 meters. The type locality is Puget Sound, Washington. *Mysella ferruginosa* Dall, 1916, described from San Francisco Bay, is a synonym. The type of *M. ferruginosa* is a specimen of *M. tumida* which is heavily encrusted with sediment.

Mysella tumida exhibits considerable variation in shell shape depending on habitat and substrate. This shell variation is similar to that of *Mysella bidentata* in the northern Atlantic Ocean (Ockelmann & Muus, 1978). In my observations, the type specimen of *M. tumida* appears to be characteristic of shallow water

specimens which live in a sandy substrate. Specimens from deeper water in muddy substrates are elongate and more compressed with the beaks more centrally placed. Preliminary data suggest *Mysella aleutica* Dall, 1899, is an elongate, compressed form of *M. tumida*, although more data must be collected to support this synonymy.

An easily identified species is *Mysella grippi* Dall, 1912. The shell is ellipsoid and evenly rounded on both ends. The beaks are central and the cardinal teeth are small and equal. It is distributed from Oregon to San Diego, California. Two lots from the Gulf of California, which I attribute to this species, were recently found in the collection of the Los Angeles County Museum. Depth distribution is from 12 to 60 meters. The type locality is San Diego, California.

Mysella pedroana Dall, 1899, is one of the largest species, attaining a length of about 10 mm. The shell is thin, highly inflated, and has anteriorly placed beaks. The anterior cardinal tooth is reduced and the posterior tooth is elongate. The species has been collected from Morro Bay, California, to San Diego, California, and is most commonly found in embayments at depths less than 25 meters. It has been found free-living in the sediment, as well as attached to the gills of the mole crab, *Blepharipoda occidentalis*. The type locality is San Pedro, California. *Mysella golischi* Dall, 1916, is a synonym. The holotype of *M. golischi* is a right valve of a juvenile *M. pedroana*.

Mysella compressa Dall, 1913, has a fragile compressed shell. The beaks are subcentral, and two small, equal cardinal teeth are present. The species is reported by Olsson (1961) to be distributed from Alaska to Peru, however the northern end of the range is questionable. I have studied hundreds of *Mysella* lots from Alaska and Oregon and have not observed *M. compressa*. On the basis of material I have studied, the northern range of the species would be Los Angeles County, California. The depth distribution is from 5 to 64 meters. The type locality is Bahia Concepción, in the Gulf of California.

A northern species, *Mysella planata* (Krause, 1885) has prominent central beaks with a small posterior cardinal and an almost absent anterior cardinal. The shell is heavy and large, reaching up to 10 mm in length. The species is distributed from the Beaufort Sea, Alaska, to the Aleutian Islands, from intertidal depths to 100 m. The type locality is Plover Bay, in the Bering Strait, Alaska. A possible synonym is *Mysella beringensis* Dall, 1916. The type of *M. beringensis* is larger than *M. planata* and slightly more compressed but the dentition of both species is very similar.

The remaining three species were described from Mazatlan by Carpenter (1857). All three species are known only from the type material which is either in poor condition or has been lost.

Mysella clemantina was described from a single damaged juvenile shell, about 1 mm in length. The type has been lost and the description is not

adequate to separate it from other *Mysella* species. The camera lucida drawings by Carpenter are all that remain to differentiate the species.

Mysella dionaea is known from a single damaged juvenile valve, 1.8 mm in length, in the British Museum. I have not had the opportunity to study the specimen, but the description indicates the valve is without teeth.

Mysella umbonata is known from four valves, all less than 1 mm in length. I have examined the two valves in the U.S. National Museum and they are in poor condition. Keen (1971) reported that the specimens in the British Museum are also in poor condition.

In addition to the described species, I have studied specimens of four potentially new species and will describe them in a forthcoming publication. The new species are found off Oregon, southern California, and in the Gulf of California.

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CLASSIFICATION OF TWO LATE CRETACEOUS GASTROPOD LINEAGES—*HINDSIA NODULOSA* (WHITEAVES, 1874) AND *FUSUS KINGII* GABB, 1864

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Hindsia nodulosa (Whiteaves, 1874) is neither a *Hindsia* nor a buccinid, although it may belong in the Buccinacea. Gastropods previously identified as *Hindsia nodulosa* constitute a new genus and can be divided into three biostratigraphically significant new species, characteristic, respectively, of Santonian, lower Campanian, and middle Campanian strata. *Fusus kingii* Gabb, 1864, is neither a *Fusus* nor a fusinid. Gastropods previously identified as *Fusus kingii* also belong in a new genus, which can

be divided into four biostratigraphically significant species, three of which are new, and are each characteristic of Coniacian, Santonian and lower Campanian strata. *Fusus kingii* is from upper Campanian strata. Early Senonian species of these new genera are similar and are closely related to *Perissistys* spp. of early Senonian age, but each lineage diverges from the others. The new genera also apparently had geographic distributions similar to that of *Perissistys* and, like it, occur in Senonian deposits of Japan as well as of the west coast of North America.

In 1983, Zinsmeister placed *Nekewis* Stewart, 1927, and *Heteroterma* Gabb, 1869, in the same family as *Cophocara* Stewart, 1927. *Cophocara* derives from *Perissistys* Stewart, 1927, and Zinsmeister thus included species formerly assigned to the Turridae within the family characterized by *Perissistys*. A new species of *Nekewis* of early Maastrichtian age greatly resembles *Hindsia nodulosa* of mid-Campanian age.

APPLIED MALACOLOGY: MOLLUSCAN DATA ON THE EVOLUTION OF THE GULF OF CALIFORNIA AND BAJA CALIFORNIA PENINSULA, MEXICO

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For years geologists considered the Gulf of California a Pliocene to Holocene (5.3 m.y. to present) embayment preceded by a "protogulf" that originated ca. 8 m.y. B.P. (before present). The area includes the boundary between the Pacific and North American Plates, a complex region of en echelon faults, spreading centers, and active volcanoes. Fossiliferous sediments associated with radiometrically dated volcanic rocks indicate that marine water was present in the area as early as 13 m.y. B.P., long before the Baja California peninsula began to separate from mainland Mexico (ca. 4 m.y. B.P.). Like the modern Gulf, the ancient one had numerous abruptly changing facies containing mollusks of Tertiary Caribbean and Pacific Panamic affinities. It extended from the head of the Salton Trough to Cabo San Lucas, as seen from Miocene mollusks in the Imperial Formation of California, Isla Tiburón, Arroyo San Nicolas, and near Santa Anita in the Cabo Trough. Marginal embayments of the early Gulf had more complex histories than previously thought; near Loreto, for example, extensive nonmarine sediments are interbedded with the shallow neritic facies that were deposited around islands of older rocks. In the late Oligocene to early middle Miocene, before there was a gulf, marine water on the Pacific side of Baja California had many of the same molluscan species as are found in the Gatun Formation of Panama.

New molluscan studies are focused on Gulf fossils to identify paleoecologic indicators, significant phylogenetic lineages, and the oldest occurrences of Tertiary Caribbean species. Geophysical models proposed for the tectonic reconstruction of southern California and west Mexico suggest that large sections of the continental borderland moved 300 - 2,500 km north in the last 20 - 100 m.y., large figures in need of refinement. So far, faunal data have not been incorporated in these models; when available, species distribution data will provide information on sources of terranes and constrain time intervals in which movement occurred.

SHELL STRUCTURE IN THE CRASSATELLINAE (MOLLUSCA: BIVALVIA: CRASSATELLIDAE) AND IMPLICATIONS FOR SUPRAGENERIC CLASSIFICATION OF CRETACEOUS AND TERTIARY SPECIES

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Most of the crassatellid species assigned to the subfamily Crassatellinae from the Upper Cretaceous of western North America reveal a distinctive subsurface pattern of radial riblets that is lacking in most west American Tertiary species. Radial riblets are present in the type species of *Crassatella* (= *C. ponderosa* (Gmelin, 1791) from the Eocene of France), and have been used by Chavan (1969) in his characterization of the family. The radial structures, which show best on weathered specimens, are due to ultrastructural and microstructural differences within the shell. The presence or absence of radial riblets is useful in segregating Cretaceous and Tertiary crassatellins into two groups on the basis of their shell types. The relationship of the radial riblets to shell ultrastructure and microstructure and their significance in suprageneric classification have been investigated with the aid of scanning electron microscopy (SEM).

The configuration of shell layers in the Crassatellidae is reported to be relatively simple, comprising an outer, crossed lamellar layer that is separated from an inner, homogeneous layer by a thin pallial myostracum (Taylor, Kennedy & Hall, 1973). Preliminary SEM examination of several nominal crassatellid genera and species with subsurface radial riblets reveals that the crossed lamellar layer is divisible into two parts, the outermost of which is comprised of distinctly larger first order lamellae than the inner part. In transverse sections, the boundary between the two parts appears as a rippled or wavy line that separates the outermost surface shell, including that of the marginal denticles, from

that deposited between the denticles and outward of the pallial myostracum.

The mid to late Cretaceous genus *Pachythaerus* Conrad, however, exhibits somewhat different features. Species assigned to *Pachythaerus* possess a denticulated inner shell margin, but lack any sign of subsurface radial riblets. SEM examination reveals a well defined outer, crossed lamellar layer, and a middle layer that probably can be assigned to the intersected crossed acicular structure type of Carter & Clark (1985). The boundary between the two shell types parallels the growth margin and shows no rippling effect.

Most west American Tertiary crassatellids also lack any sign of radial shell structure. Because species with radial riblets represent a derived condition from some non-radially ribbed ancestor, it is unlikely that they evolved from typical *Crassatella*. The enlarged resiliifer in most Tertiary species suggests that they evolved either 1) from an ancestral *Pachythaerus*-like stock, or 2) represent an independent evolution from an unspecified astartacean ancestor. Weakly developed radial structures in some modern *Eucrassatella* (*sensu lato*) are also believed to represent a derived condition, and are not necessarily indicative of evolution from the typical *Crassatella* lineage.

Results of this preliminary study indicate that 1) shell microstructure and ultrastructure should be taken into consideration in any systematic revision of the family Crassatellidae, and 2) that North American and European Cretaceous and Tertiary species can be allocated into several suprageneric groups that are defined, in part, by details of their shell structure. Formalization of these groups, perhaps at the tribe level, is withheld pending further study of fossil and Recent Crassatellidae on a world-wide basis.

TAXONOMIC REVISION OF THE NEOGASTROPOD FAMILY TURRIDAE FROM THE DOMINICAN REPUBLIC NEOGENE

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The Neogene Yaque Group of the northwestern Dominican Republic has yielded a diverse, abundant, and well-preserved fauna of the neogastropod family Turridae. My work has concentrated on reconciling the often convoluted nomenclature of Caribbean species and documenting the stratigraphic and biogeographic distribution of taxa. [Program Summary]

A COMPARISON OF THE MINUTE MARINE SHELLS OF THE MIDWAY ISLANDS WITH THOSE OF THE ISLAND OF HAWAII

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After two years of research on the minute marine shells of Hawaii, I had the opportunity to study and identify similar shells collected by Donald R. Shasky from twelve locations in the Midway Islands, representing over 160 species also found in Hawaii. Midway was formed about seven million years ago while Hawaii is about one million years old on its west side and only a few thousand years on the east side. The ocean currents flow from east to west on both sides of the 1500 mile long chain of islands between Hawaii and Midway, thus migration by ocean currents is from the newest island to the oldest. All specimens from Midway are from depths of two to eight meters, while many of the 300 plus species from Hawaii are from greater depths.

Noticeable differences were mainly in color and/or sculpture, but were limited to only about 30 species of the 160 studied. The variations were found mostly in species that live by filter feeding or grazing. These species are less likely to be replenished by migration in the currents, so are more likely to be affected by evolutionary changes at the older Midway atoll. Differences in numbers of any species collected at the two areas were disregarded due to the limited period of collecting at Midway.

Species cited for differences in sculpture and color:

Euchelus gemmatus (Gould, 1895)

Joculator ridicula Watson, 1866

Leptothyra verruca (Gould, 1845)

Species cited for differences in sculpture only:

Scissurella pseudoequatoria Kay, 1979

Vanikoro cancellata (Lamarck, 1822)

Species cited for differences in color only:

Gibbula marmorea (Pease, 1867)

Tricolia variabilis (Pease, 1861)

Schwartzia gracilis (Pease, 1861)

Caecum septimentum de Folin, 1867

Trivia exigua Gray, 1930

Kermia aniani Kay, 1979

Julia exquisita Gould, 1862

Leptothyra rubricincta (Mighels, 1845)

Rissoina ambigua (Gould, 1849)

Lophocochlias minutissimus (Pilsbry, 1921)

Cerithium placidum Gould, 1861

Lienardia baltreata (Pease, 1860)

Koloonella hawaiiensis Kay, 1979

Kellia rosea Dall, Bartsch & Rehder, 1938

Species cited for being found only at Midway in my study:

Alvania (Alvania) isolata (Laseron, 1956)

Euplicia turturina (Lamarck, 1822)

Species cited for being found at Midway and Maui, but not Hawaii:

Barleeia sp.

Collecting done along the outer side of the atoll reefs at Midway would undoubtedly add many other species to the Midway total.

ANGARIINAE AND LIOTIINAE— THE PRIMITIVE LIVING TROCHACEANS

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Angaria and *Liotia* (and related genera) are considered the most primitive living trochacean gastropods, based on characters of aperture angle, gill, radula, operculum, and epipodium. Aperture angle is nearly radial, not oblique as in higher trochaceans; the foot consequently does not expand across the base of the shell. The bipectinate gill has a short afferent membrane, unlike the condition in higher trochaceans in which there is a long afferent membrane. The radula in both groups is similar to that of the homalopomatine turbinids. The operculum is multispiral; that of *Angaria* is chitinous like that of trochids; that of *Liotia* and allies has external calcareous beads; yet the opercula of both groups differ from those of trochids in having a broader zone of accretion. Although the thick, calcareous operculum of the homalopomatine turbinids is enveloped externally, the broad zone of accretion on its internal surface corresponds to its paucispiral pattern. Epipodial development in *Angaria* and *Liotia* is minimal; lappets are lacking and neck lobes are simple, as in homalopomatine turbinids. All trochids have a more advanced epipodium and radular plan that varies from group to group. Liotiinae may be traced to the Permian. The subfamilies Angariinae and Liotiinae are placed at the base of the Turbinidae, thereby making Turbinidae, advanced members of which have fully calcified opercula, more primitive than Trochidae.

This work is preliminary to a full review of trochacean classification in collaboration with C.S. Hickman.

EVOLUTIONARY RELATIONSHIP BETWEEN FOSSIL AND MODERN MICRARIONTA (PULMONATA: HELMINTHOGLYPTIDAE) ON SAN NICOLAS ISLAND, CALIFORNIA

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Micrarionta opuntia Roth, 1975, and *M. sodalis* (Hemphill, 1901) are helminthoglyptid land snails having morphologically similar shells. The two species are found only on San Nicolas Island, one of five southern California islands where the twelve species of *Micrarionta* are endemic. Stratigraphic

evidence, combined with radiometric dating indicates that *M. sodalis* existed on the island before 120,000 years ago, and *M. opuntia* appeared on the island in the latest Pleistocene roughly 18,000 years ago. The two species coexisted on the island with a gradual change in dominance from *M. sodalis* to *M. opuntia*, then *M. sodalis* became extinct less than 3400 years ago, while *M. opuntia* persisted. Morphometric analyses show that the shell of *M. opuntia* is morphologically more similar to that of *M. sodalis* than to the shells of any other species of *Micrarionta*. The stratigraphic evidence and results of the morphometric analyses support the view that *M. opuntia* evolved on San Nicolas Island from *M. sodalis* rather than having been introduced from elsewhere. Relative constancy in shell characters through time of the two species, bimodal frequency distributions of the two species in a number of size and shape characters, and stratigraphic evidence that *M. opuntia* and *M. sodalis* coexisted on the same part of the island while maintaining their distinct morphologies, indicates cladogenic evolution and confirms the taxonomic validity of the two species. A climatic increase in aridity, or collecting activities of Native Americans may have been factors influencing the extinction of *M. sodalis*.

NOTES ON THE ZOOGEOGRAPHY OF THE BULMULIDS (PULMONATA: SIGMURETHRA) OF SONORA, MEXICO

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The zoogeographic patterns presented by land snails in Sonora are discussed with emphasis on the Bulmulidae, in which a few species are extremely widespread while others inhabit only local areas. This pattern is explained, and the applicability of some biogeographical theories to the land snails in Sonora is explored. [Program Summary]

FAUNAL RELATIONSHIPS OF THE WESTERN ATLANTIC ARCHITECTONICIDAE

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Based on a forthcoming worldwide revision of the Recent species in the family Architectonicidae, the Western Atlantic architectonicid fauna has been compared with other such faunas in the Eastern Pacific, Indo-West Pacific, Eastern Atlantic, Mediterranean and with the fossil record in the Caribbean Tertiary. It is demonstrated that there are only small differences between West Atlantic, East Atlantic and Mediterranean architectonicid faunas; most

species are shown to have an amphi-Atlantic distribution. Only three major architectonicid faunas are here recognized worldwide: Atlantic (including Mediterranean), Indo-West and Central Pacific, and East Pacific. Architectonicids are a slowly evolving group (this can be explained by their long-range larval dispersal that allows a constant gene flow across ocean basins); their major radiation leading to Recent species took place before the oceans separated in the Middle Miocene and Pliocene. The differences between the three modern architectonicid faunas can be explained by the post-Pliocene extinction of different parts of the Neogene stock in the Eastern Pacific and in the Atlantic.

MOLLUSKOCYSTIS, GREGARINE PARASITE OF HETEROPOD MOLLUSCS (GASTROPODA: PTEROTRACHEIDAE)

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Heteropod mollusks collected off California and Hawaii were surveyed for parasites. A total of 111 individuals, representing 7 species, 4 genera and 2 families, were critically examined. Two species of pterotracheids from off Oahu, Hawaii were infected with septate gregarines of the genus *Molluskocystis*. The sporozoans were found exclusively in the haemocoel of the heteropod hosts. Originally described by Stuart (1871) from an unidentified species of *Pterotrachea* in the Black Sea off Odessa, the gregarine was later reported by Tregeboeff (1918) to infect *P. coronata* and *P. mutica* (now known to be synonymous with *P. hippocampus*) off Villefranche, in the Mediterranean. In our studies the type species, *M. pterotracheae*, was rediscovered and is redescribed from *P. hippocampus*. Gregarines infected 70% of the hosts examined and specifically attached to the oesophagus. A second, new species of gregarine was found in *Firoloida desmaresti*. In this second case, the incidence was 100% and the parasite specifically attached to the buccal mass, foot and body wall of the host. This is the first report of gregarines infecting heteropod mollusks in the Pacific Ocean.

MOLLUSKS FOUND ON RIO GRANDE BREAKWATER

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The marine mollusks that live on the Rio Grande breakwater were studied. The material was collected

on supratidal rocks by the author and to a depth of 10 meters by scuba divers. A total of 20 species was recovered. The malacofauna is similar to that found on Rio Grande breakwater buoys (Rios, 1979), with the exception of *Littorina ziczac* and *Siphonaria lessoni*, never found on buoys.

HISTOCHEMISTRY AND MORPHOLOGY OF THE ATTACHMENT THREAD OF *CORBICULA FLUMINEA* (BIVALVIA: CORBICULIDAE)

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The Asiatic clam, *Corbicula fluminea*, produces a fragile, ephemeral attachment thread after settlement, usually when clams are less than 9 mm in shell length. Histochemical tests demonstrate that threads are mucilaginous in composition. Metachromatic staining with toluidine blue and thionin indicate mucin. Threads stain positively with alcian blue at pH 0.5 to 1.0 and also at pH 2.5, indicating that threads contain both sulfated and non-sulfated mucopolysaccharides. The thickened stump of the thread, which attaches to the substratum, stains differently than the elongated strand of the thread. Alcian blue stains the stump less strongly than the strand, suggesting that mucopolysaccharides in the stump are less acidic than those in the strand. The Periodic Acid-Schiff (PAS) reaction followed by alcian blue demonstrates that the stump, which stains blue, is more alcianophilic relative to the strand, which stains magenta, and is therefore more periodate-reactive. Two protein tests, the Millon reaction and the Ninhydrin reaction, were negative, suggesting that protein is probably not a component of *Corbicula* attachment threads.

Scleroprotein byssal threads from the marine mussels *Geukensia demissa* and *Mytilus edulis* were stained with thionin, toluidine blue, and alcian blue, and compared to *Corbicula* threads. Although mussel threads demonstrate weak metachromasia, they are non-alcianophilic, thus mucilaginous *Corbicula* attachment threads are different in composition than byssal threads.

Scanning electron micrographs demonstrated that the *Corbicula* attachment thread emerges from a glandular groove in the foot of the clam, roughly one quarter of the way along the length of the foot, and is deepest near the point where the thread emerges. The groove is possibly homologous with the byssal gland of other bivalves.

Clams attach most commonly to small pebbles 3 to 5 mm in size, and may also attach to sand, mud, and other clams. Several clams may clump with pebbles and detritus, held together with attachment threads and mucous secretions that make clams sticky. Threads are elastic and can stretch to nearly twice their length before breaking.

DENDRODORIDIDAE OF THE NORTHERN MEDITERRANEAN

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In the northern Mediterranean two species of *Dendrodoris*, *D. limbata* (Cuvier, 1804) and *D. grandiflora* (von Rapp, 1827), are frequent, whereas the five species described by Pruvot-Fol (1951) are rare and nearly unknown. One of these, *D. languida*, has possibly been rediscovered. The anatomy and embryology are described. [Program Summary]

SCANNING ELECTRON MICROSCOPE OBSERVATIONS OF MICROPROJECTIONS ON THE PARIETAL LAMELLA IN *GASTROCOPTA* AND *VERTIGO* (PULMONATA: PUPILLIDAE)

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The presence of microprojections on the apertural lamellae of pupillids was first reported in *Vertigo milium* (Gould, 1840) by Alan Solem (1972). He also noted their presence in *Gastrocopta*, with observable variation at the species level, exhibiting changes in frequency of occurrence and prominence of microprojection development, which is correlated with shell growth (Solem & Lebyrk, 1975). Scanning electron microscope comparisons of the microprojections found on the surface of the parietal lamella in mature representatives of each of the subgenera of *Gastrocopta* demonstrate that microprojection frequency and development are fairly consistent at the subgeneric level, yet exhibit considerable differentiation between subgenera. Even greater differentiation in the morphology of the microprojections of the parietal lamellae of mature *Vertigo* demonstrates a need for a comparable level of taxonomy within this genus. Further study is needed before the limits of differentiation of apertural microprojections among the so called "Groups" of *Vertigo* are fully understood.

FACTORS AFFECTING LARVAL LONGEVITY AND SETTLEMENT IN THE OPISTHOBRANCHIA

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Minimal precompetent larval periods tend to characterize opisthobranch taxa at the generic or family level. While sensitive to both temperature and nutrition, larval growth to a similar settling size among related opisthobranchs appears to be a driving factor. Once metamorphically competent,

opisthobranch larvae settle and metamorphose in response to stimuli associated with specific algal or animal prey, or, for those whose prey is motile, substrata characteristic of the prey. [Program Summary]

REPRODUCTIVE AND LARVAL STRATEGIES OF NUDIBRANCH MOLLUSCS

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The energy budget of an individual organism is both finite and subject to additional constraints. The classical view has been that heavy expenditure in one component (e.g., respiration) is necessarily balanced by compensatory reduction in another (e.g. reproduction); this is not necessarily so, for some species appear profligate in all components, while others display low all-round energy flux. Nevertheless, within the organism's energetic constraints selection should favour the numerical maximization of offspring production (irrespective of reproductive effort, or relative "efficiency" in terms of offspring per joule). The concept of reproductive strategy has been summarized as the organism's set of physiological, morphological and behavioural traits that dictate the "where," "when," "how often" and "how many" tactics of propagule production. But benthic marine invertebrates are characterized by a further variable — "what kind of" offspring? Broadly, marine invertebrate larvae are divisible into planktotrophic and lecithotrophic categories. While the former are, by definition, pelagic the latter are not necessarily so. Indeed, the apparent evolutionary trend of planktotrophy to pelagic lecithotrophy to non-pelagic lecithotrophy appears to lead towards parental retention and brooding in many phyla. What remains to be evaluated, therefore, are the selective pressures which have dictated the relinquishing of the primitive, or ancestral, planktotrophic mode of reproduction in favour of lecithotrophy. Pursuit of an all-embracing explanation to this ecological puzzle is almost certainly futile, and we must therefore accept that each species probably constitutes its own "special case."

Comprehensive observations of the reproductive energetics of two dorid nudibranchs with contrasting larval strategies lead me to conclude that the adoption of pelagic lecithotrophy (with its implicitly higher probability of individual larval survival) has arisen as a result of individual adult unpredictability of energy flux to reproduction. Here the "risk" element of planktotrophy is curtailed at the expense of reduced numerical potential and the putative advantages of large-scale larval dispersal. I present experimental data to show the differential reproductive responses of *Onchidoris muricata* (planktotrophic) and *Adalaria proxima* (pelagic lecithotrophic) to varying food (energy) availability. Finally, I

present preliminary observations of the population genetic implications of these contrasting larval strategies.

DISTRIBUTION AND ECOLOGICAL ADAPTATIONS OF INTERSTITIAL MOLLUSCS IN FIJI AND A DISCUSSION OF AN INTERSTITIAL MOLLUSCAN ASSEMBLAGE

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An interstitial mollusc assemblage from Fiji is described and characterized. A similar assemblage consisting of representatives of three higher gastropod taxa is shown to be characteristic of comparable habitats worldwide. [Program Summary]

INTERSTITIAL OPISTHOBRANCH GASTROPODS: ECOLOGICAL AND BIOLOGICAL ACCOUNT

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ABSTRACT

The presentation summarizes recent data about systematics, ecology, population dynamics (long, medium and short-term variations), reproductive biology and teratology of interstitial opisthobranch gastropods.

SYSTEMATIC REMARKS

The interstitial opisthobranchs include 4 orders (Arnaud et al., 1986): Cephalaspidea (Philinidae, Philinoglossidae); Sacoglossa (Platyhedylidae, Stiligeridae); Acochlidomorpha (Hedylopsidae, Aspersinidae, Microhedylidae, Ganitidae); and Nudibranchia (Pseudovermidae, Tergipedidae). Out of something like 1500 opisthobranch species in the world, only 54 are interstitial, among which 24 have been recorded along the West European coasts. However, many seashores in the world have never been prospected with the special aim to collect interstitial/meiobenthic gastropods. Numerous species remain to be discovered, which will certainly lead to a better understanding of the systematics of this group which has specialized to interstitial conditions (Swedmark, 1959, 1968).

DISTRIBUTION

Interstitial opisthobranch gastropods are presumably present in most sublittoral sedimentary substrates. In the localities of the northwestern Mediterranean, these interstitial organisms are particularly abundant in coarse sands ($0.75 < \phi < 1.50$ mm), very coarse sands ($1.50 < \phi < 2.0$ mm) and granules ($2.0 < \phi < 4.0$ mm) of high homogeneity (low sorting index) that are frequently poor in silt-clay

particles (<5%) and organic detritus (Poizat, 1981 a). These sediments result from very exposed bottom, where waves and currents cause a continuous rearrangement of the sand grains, oxygenation and movement of the interstitial water resulting in a very clean environment devoid of pollution (Poizat, 1985). Under such optimal ecological sedimentary conditions, interstitial opisthobranchs remain generally restricted to a very small group which averages a frequency of only 1.5 to 2.5% of the total interstitial fauna (Poizat, 1981 a & b). But these organisms are involved in very remarkable assemblages (Arnaud et al., 1986; Poizat, 1986b, 1985; Salvini-Plawen, 1984) where up to 12 species can live closely together (fig. 1), associated with interstitial prosobranchs (Caecids particularly).

LONG TERM VARIATION OF INTERSTITIAL OPISTHOBRANCH ASSEMBLAGES

Interstitial opisthobranch assemblages may be more or less perturbed (either in the vicinity of polluted areas, or as a result of long term regional oceanographic changes), according to the respective sensitivity of the various species involved (Poizat, 1983a). For instance, in the Gulf of Marseille, a drop in marine hydrodynamism correlated with increased human pollution, was recorded from 1970 to 1976. This phenomenon resulted in the disappearance of two rare species, *Platyhedyle denudata* Salvini-Plawen, 1973, and *Pseudovermis papillifer* Kowalevsky, 1901, and in a long term progressive change in the abundance of the dominant species. Several very sensitive species, *Philine catena* and other macrobenthic species of *Philine*, wholly disappeared from the region. Two sensitive species, *Hedylopsis spiculifera* (Kowalevsky, 1901) and *Embletonia pulchra* Alder & Hancock, 1844, slowly declined in abundance. At the same time the not very sensitive species increased regularly, gradually replacing the declining species. These increasing species, *Pontohedyle milaschewitschii* (Kowalevsky, 1901), *Unela glandulifera* (Kowalevsky, 1901) and *Philineoglossa helgolandica* Hertling, 1932, appeared therefore as the most resistant interstitial opisthobranchs (Poizat, 1983a, 1985).

SEASON CYCLES OF INTERSTITIAL OPISTHOBRANCH ASSEMBLAGES

In favourable Mediterranean biotopes (high exposure ones), seasonal variations in abundance of interstitial opisthobranchs are very marked (fig. 2A). There is normally a marked rise in the abundance of the mollusks in the boundary layer, from spring to summer, with a peak during the warm and calm season, alternating with a zero minimum in winter (Poizat, 1984a). Such variations are linked to vertical migrations of the organisms that are related to seasonal hydrodynamic changes inducing variations of the sediment grain-size, of the sea water temperature and dissolved oxygen content. Grain size, pore space and oxygen content are maximum in winter favoring the vertical migration of the interstitial

opisthobranchs toward the deepest sand layers, and conversely, grain size-pore space and oxygen content at a minimum in summer, leading to the concentration of interstitial opisthobranchs in the shallow boundary layer (upward migrations). Such seasonal changes may be modified (fig. 2D & G) along exposure and/or pollution gradients, depending on the sensitivity of the species involved (Poizat, 1985).

SHORT TERM VARIATIONS OF INTERSTITIAL ASSEMBLAGES

Short term variations (fig. 3) have been identified and linked to variations in the sand redox potential (interruption of photosynthesis during the night) and also to the possible occurrence of vertical and horizontal migrations for trophic and reproductive purposes (Poizat, 1983b).

LIFE CYCLES OF A FEW MEDITERRANEAN INTERSTITIAL OPISTHOBRANCHS

Poizat (1986a) describes the reproductive activity of some of these organisms. The 2 dominant Mediterranean hermaphroditic interstitial species, *Philine catena* and *Embletonia pulchra*, have an annual cycle, with a single striking recruitment period in summer and/or autumn (fig. 4A). The hermaphroditic Acochliidae *Hedylopsis spiculifera* is probably also an annual species which undergoes one generation per year, but there is a prolonged recruitment period from the end of spring to the end of autumn and adults can be observed from winter to summer. The two monosexual Acochliidae, *Pontohedyle milaschewitschii* and *Unela glandulifera*, proved to be subannual species, which undergo 2 generations per year, generally spring and fall in the Mediterranean (fig. 4B). Both species reproduce by means of spermatophores. *Pontohedyle milaschewitschii* has one, sometimes 2, and exceptionally 3 very short spermatophores attached to each animal, most commonly to the dorsal part of the visceral hump. *Unela glandulifera* has one, and rarely 2 very long spermatophores (almost as long as the visceral hump) attached generally on the dorsal part of the visceral sac, but sometimes in front of the head-foot complex (Poizat, 1986a).

TERATOLOGICAL SPECIMENS OF INTERSTITIAL OPISTHOBRANCHS

Among the interstitial opisthobranchs, as well as the benthic ones, aberrant specimens are occasionally observed, but very few data have been published to document the abnormalities. Only 2 interstitial European species, *Embletonia pulchra* and *Hedylopsis spiculifera*, revealed unusual aberrant morphologies (fig. 5) (Poizat, 1986b). Two more species proved temporarily very slightly abnormal, during their post-larval growth (negative allometry). In *Pontohedyle milaschewitschii* and *Unela glandulifera*, the visceral hump was unusually shortened in a few juvenile specimens. These teratological features are not lethal since the abnormal individuals exhibited normal behaviour several days after

collection. Most of these features are chronic in the 2 first involved species. They have been classified in 3 decreasing degrees of seriousness: 1) chronic abnormalities represented by a lack of one or several parts of the body (oral veil, rhinophores, cerata; see fig. 5A, B, C & E) and presumably resulting from a serious and early injury (by pollution?) during larval life or metamorphosis, and therefore without possibility of readjustment; 2) chronic abnormalities represented only by a more or less acute malformation due to a wrong readjustment (slender axis of the tail, see fig. 5D; verrucosities on the visceral hump, see fig. 5H & I) following a slight injury (bite, etc.) inflicted to the animal after its metamorphosis; 3) temporary abnormalities recorded in juvenile specimens only (negative allometry) readjusted in a normal way during growth.

As a conclusion to this ecological and biological account, it must be emphasized that interstitial opisthobranchs could be regarded as indicator organisms which characterize a clean sedimentary environment devoid of pollution. Indeed as soon as pollution occurs in an area, disappearance of the rare species as well as changes in the abundance of dominant species are recorded together with modifications of their season cycles.

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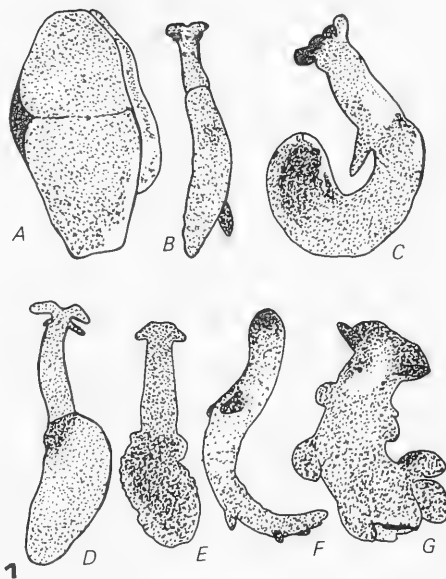


FIGURE 1

Interstitial opisthobranch assemblage from Embiez Archipelago, including 7 species : A = *Abavopsis latosoleata* Salvini-Plawen, 1973 (adult, length = 0.72mm, dorsal view). B = *Hedylopsis spiculifera* (Kowalevsky, 1901), (adult, L = 3.22mm, dorsal view). C = *Asperspina* sp (juvenile ?, L = 0.68mm). D = *Unela glandulifera* (Kowalevsky, 1901), (adult, L = 1.80mm, dorsal view). E = *Pontoledyle milaschewitschii* (Kowalevsky, 1901), (juvenile, L = 1.5mm, dorsal view). F = *Pseudovermis papillifer* Kowalevsky, 1901 (adult, L = 1.34mm, right side). G = *Embletonia pulchra* Alder & Hancock, 1844, (juvenile, L = 0.90mm, dorsal).

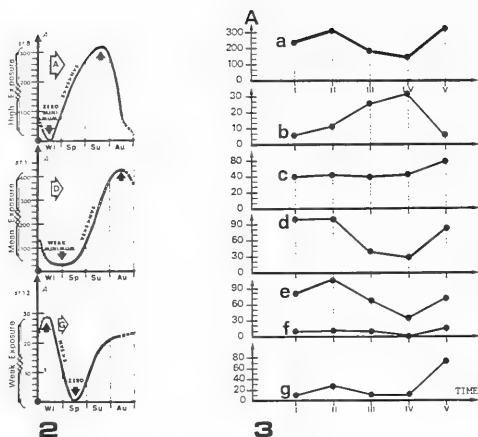


FIGURE 2

Seasonal cycles of interstitial opisthobranch assemblages along an exposure gradient: A = high exposure, D = mean exposure, G = weak exposure. S = sensitive species, VS = very sensitive, NVS = not very sensitive. A = abundance in 50 dm³ sand. Wi = Winter, Sp = Spring, Su = Summer, and Au = Autumn.

FIGURE 3

Variation of the abundance (A/ 50 dm³ sand) of the 6 dominant species, in a gravel locality of the Gulf of Marseille, during the

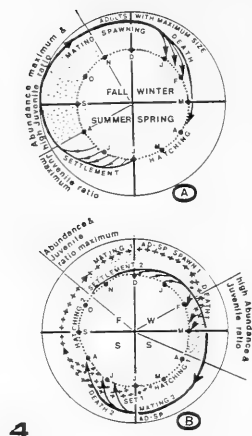


FIGURE 4

period of observation: I = 18 h 45; II = 22 h 30 (April 19, 1974), III = 01 h 00; IV = 03 h 20; V = 05 h 15 (April 20, 1974). a = total assemblage; b = *Philine catena*; c = *Hedylopsis spiculifera*; d = *Embletonia pulchra*; e = *Unela glandulifera*; f = *Pontohedyle milaschewitschii*; g = *Philineglossa helgolandica*.

Interpretative seasonal reproductive cycle of: A = annual species *Philine catena*, with only one generation per year. B = subannual species *Unela glandulifera*, with 2 generations per year. AD-SP = adults with spermatophores.

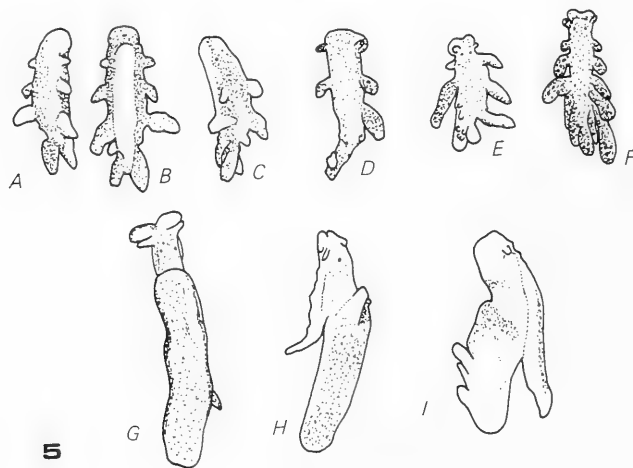


FIGURE 5

Drawing from photographs of living specimens: A, B & C = right, ventral and left view of an abnormal 1.75 mm specimen of *Embletonia pulchra*, from Marseille: devoid of rhinophores & oral veil, with only 5 cerata on the right side, 4 on the left side of the dorsum. D = dorsal view of an abnormal 1.5 mm specimen from Northern Ireland, with round oral veil, low number of cerata and slender tail. E = dorsal view of a 1.5 mm abnormal specimen from Marseille with buds of cerata on left rear side of the body. F =

dorsal view of an adult normal specimen from Western Sweden, 3.00 mm long, with long cylindrical rhinophores, bilobed oral veil and 13 cerata. G = dorsal view of a normal 1.5 mm adult *Hedylopsis spiculifera* from Marseille. H = left view of a 1.8 mm long abnormal specimen with 2 symmetrical expansions at the front dorsal part of the visceral hump. I = right side of a 1.3 mm long abnormal specimen with 3 odd verrucosities on the dorsal median line of the visceral hump.

SACOGLOSSAN POPULATION STUDIES

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Sacoglossan populations of Belize and Florida mangrove and reef habitats are compared. Higher densities and diversity occur in mangrove habitats. Peak densities increase with latitude, but high-latitude populations are generally transient while tropical populations are stable. [Program Summary]

THE SACOGLOSSA OF GUAM

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Fifteen years of study on Guam have resulted in a collection of almost 400 Opisthobranchia. The algae dependent order Sacoglossa is represented by 76 species. Much of the collecting has been done in a small area known as Bile Bay, where 52 of the 76 Sacoglossa have been found. Following the sub-orders listed in Marcus (1982), the representative number of species is as follows:

Juliacea	2
Volvatellacea	6
Oxynoacea	5
Elysiacea	39
Polybranchiacea	24

Although the number of species is fairly large, few have been found with any regularity and many of the species are represented by only one or two specimens. The number of species obtained probably reflects the time spent collecting rather than that Guam offers a unique habitat for Sacoglossa.

The algal associations for most of the species are still unclear. All but two of the shelled forms are found on *Caulerpa*, while members of the genus *Costasiella* are invariably found on the alga *Avrainvillea*. Research has begun at the University of Guam Marine Laboratory, looking for metabolites in some of the Sacoglossa. If successful, it will be easier to find out who eats what.

The sacoglossan species we have collected at Guam are:

Ascobulla japonica (Hamatani, 1969)
Volvatella viridis Hamatani, 1976
Volvatella pyramidalis Pease, 1868
Volvatella spp. (3)
Oxynoe viridis (Pease, 1863)
Oxynoe kabirensis Hamatani, 1980
Oxynoe spp. (2)
Lobiger souverbiei Fisher, 1856
Julia exquisita (Gould, 1862)
Berthelinae sp.
Placobranchus ocellatus van Hasselt, 1824
Placobranchus sp.
Pattyclaya arena (Carlson & Hoff, 1977)
Elysia bayeri Marcus, 1965
Elysia bennettiae Thompson, 1973
Elysia caerulea Kelaart, 1859

Elysia cauze Marcus, 1957
Elysia degeneri Ostergaard, 1955
Elysia gracilis Risbec, 1928
Elysia grandifolia Kelaart, 1859
Elysia halimeda Macnae, 1954
Elysia marginata (Pease, 1871)
Elysia mercieri Pruvot-Fol, 1930
Elysia obtusa Baba, 1938
Elysia ratna Marcus, 1965
Elysia rufescens (Pease, 1871)
Elysia vatae Risbec, 1928
Elysia yaeyamana Baba, 1936
Elysia spp. (15)
Stiliger varians Eliot, 1904
Stiliger spp. (5)
Costasiella spp. (5)
Polybranchia orientale (Kelaart, 1859)
Cyerce elegans (?) Bergh, 1888
Cyerce nigricans (Pease, 1866)
Cyerce and *Polybranchia* spp. (6)

A COMPARATIVE INVESTIGATION OF CHEMORECEPTION OF FOOD ATTRACTANTS

Kathe Jensen

Zoologisk Museum
Universitetsparken 15
DK 2100 Copenhagen, Denmark

Behavioral responses to homogenates of food and non-food plants before and after gel-filtration were tested in 6 species of Florida Sacoglossa. The results were correlated with diet width, food preferences, and protein content of homogenates. The responses may reflect dietary evolution with the Sacoglossa. [Program Summary]

AEOLID NUDIBRANCHS AS PREDATORS AND PREY

Larry G. Harris

University of New Hampshire
Durham, New Hampshire 03824

The biology and autecology of aeolid nudibranchs are much better known than are the roles nudibranchs play in the communities in which they occur. This report describes known and potential roles aeolid nudibranchs play as both predators on cnidarians and other species and as prey to higher trophic level predators. [Program Summary]

THE GENUS BATHYDORIS: IMPLICATIONS FOR NUDIBRANCH PHYLOGENY

Hans Bertsch

Biological Sciences
National University
Los Angeles, California 90301

The anatomy of species of *Bathydoris* was contrasted with that of other opisthobranch mollusks. Primitive and derived characteristics are described within the framework of their functional morphology. Two alternative phylogenies of the nudi-

branches are presented (Figures 1 and 2). The hypothetical ancestral nudibranch is inferred to have been similar to gnathodorid nudibranchs.

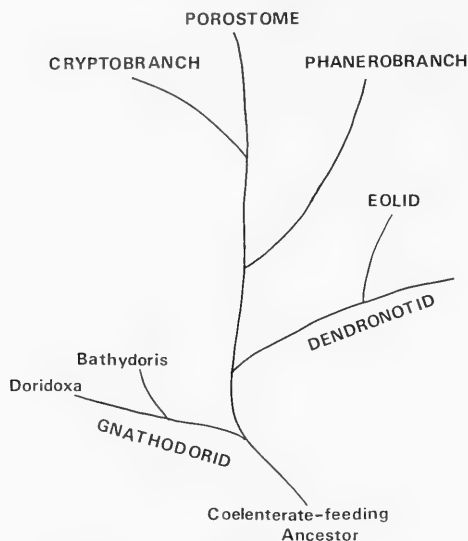


FIGURE 1

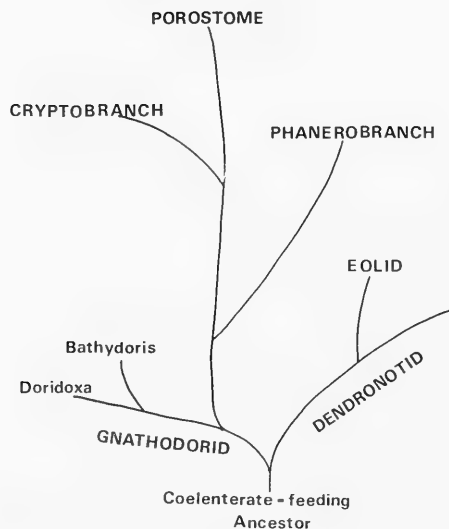


FIGURE 2

PHYLOGENETIC SYSTEMATICS OF THE ORDER NOTASPIDEA (OPISTHOBRANCHIA) WITH REAPPRAISAL OF FAMILIES AND GENERA

Richard C. Willan

Department of Zoology
University of Queensland
St. Lucia, Brisbane, Australia 4067

States for 57 behavioral and anatomical characters are tabulated for each genus of the order Notaspidea. Primitive and advanced conditions for each character are inferred on the basis of outgroup comparisons. A phylogenetic cladogram is compared to an unweighted, computer-generated dendrogram. Data from these analyses are employed in reappraising higher taxa of the order. [Program Summary]

COLOR IN OPISTHOBRANCHS

Malcolm Edmunds

Lancashire Polytechnic
Preston, United Kingdom

Evidence for the possible functions of color in opisthobranchs is reviewed. There is no evidence for the occurrence of intraspecific color signals, nor for fortuitous colors, so it is probable that all colors function in interspecific contexts, most (or perhaps all) being anti-predatory in functions.

There is abundant evidence for crypsis in opisthobranchs and from this certain nudibranchs have evolved precise special resemblances to their food in the form of sponge or coelenterate mimicry. Some opisthobranchs can change color to match their food by sequestering pigments from it.

Warning colors and Mullerian mimicry probably occur in some opisthobranchs, but evidence for these functions is largely indirect. Colors may also be used in a few species to deceive predators (flash coloration); to intimidate them (deimatic behavior); or to direct attacks to expendible and/or noxious parts of the body (deflective marks), but experimental studies are lacking. There is tremendous scope for critical experimental studies of color in predator-prey interactions in opisthobranchs.

[Program Summary]

BIOGEOGRAPHICAL PATTERNS IN OPISTHOBRANCH GASTROPODS

Terrence M. Gosliner

Department of Invertebrate Zoology
California Academy of Sciences
San Francisco, California 94118

Differences in biogeographical patterns of opisthobranchs of southern Africa are described. Differences in levels of endemism between prosobranchs and opisthobranchs are discussed. The importance of levels of endemism in evaluating biogeographical hypotheses is explored. [Program Summary]

ASPECTS OF DISPLAYING LIVE CEPHALOPODS

Roland C. Anderson
The Seattle Aquarium
Seattle, Washington 98101

The Seattle Aquarium regularly displays *Octopus dofleini* and *O. rubescens* along with a sepiolid, *Rossia pacifica*. In addition to these local species, *Nautilus pompilius* is displayed in a tropical gallery. *Loligo opalescens* is displayed seasonally and *Sepia officinalis* has been displayed as space and supply of animals have been available. Three other cephalopods have been kept in non-display tanks. Exhibiting these animals for public display is usually a challenge. The Aquarium has used some interesting methods for presenting these cephalopods to the public, solutions that keep the animals healthy yet available for viewing by literally thousands of people. Methods include use of an acclimation period in a holding tank, where the animal gets used to the conditions of confinement. The process of confining an octopus can be a challenge in itself, which is met by suitably enclosing the holding and display tank. While on display the animal is provided a natural appearing habitat, such as artificial caves or substrate, that also lets the animal be visible to the public. Red light, low-level lighting, mylar coatings on the glass and one-way mirrors have been tried to reduce animal stress. Water quality and food quality is closely monitored. Some of the cephalopods have reproduced while on display, indicating good adjustment to captivity.

COLOR AND BODY PATTERNING IN CEPHALOPODS FROM LIZARD ISLAND, AUSTRALIA

Clyde F. E. Roper

Department of Invertebrate Zoology, Division of Mollusks
National Museum of Natural History
Smithsonian Institution, Washington, D.C. 20560
and

F. G. Hochberg, Jr.

Department of Invertebrate Zoology
Santa Barbara Museum of Natural History
Santa Barbara, California 93105

Cephalopods were observed *in situ* and under laboratory conditions at Lizard Island, Great Barrier Reef, Australia. Observations on habitat, feeding, and activity patterns were discussed. The major components and patterns of body displays are described for *Octopus cyanea*, *O. ornatus*, *Hapalochlaena* spp., *Metasepia pfefferi*, and *Sepia papuensis*. A remarkable new type of locomotion, "ambling," is described for *M. pfefferi* which we observed live for the first time. Observations of live *Hapalochlaena* made at Lizard Island and in Sydney and on color photographs from several other localities confirm the existence of a widespread complex consisting of at least 3 species. A total of 24 species of cephalopods is recorded from Lizard Island. Based on observations of living animals and a systematic evaluation of

specimens, the presence of *Octopus ornatus* and *Idiosepius pygmaeus* in Australian waters is reported for the first time.

VISUAL RECOGNITION OF SPECIES IN THE TWO-SPOTTED OCTOPUS COMPLEX

F. G. Hochberg, Jr.

Department of Invertebrate Zoology
Santa Barbara Museum of Natural History
Santa Barbara, California 93105

Adults of *Octopus bimaculatus* and *O. bimaculoides* are morphologically almost identical. Pattern differences in the ocelli and mantle white spots of live animals provide visual clues which aid in species determination. The validity of *O. oculifer* and *O. roosevelti* will be discussed. [Program Summary]

A CATALOG OF THE TYPE SPECIMENS OF RECENT CEPHALOPODA DESCRIBED BY S. STILLMAN BERRY

Michael J. Sweeney, Clyde F. E. Roper

Department of Invertebrate Zoology
National Museum of Natural History
Washington, D.C. 20560
and

F. G. Hochberg, Jr.

Department of Invertebrate Zoology
Santa Barbara Museum of Natural History
Santa Barbara, California 93105

The primary type specimens of recent cephalopods described by S. Stillman Berry (1887-1984) have been traced and the museums in which they are deposited verified. Specimen data, collection data, and museum catalog numbers are given for all specimens. Specimens known to be no longer extant and those types that could not be located are noted. A bibliography of Berry's cephalopod publications is included.

OCTOPOD PARALARVAE FROM HAWAIIAN WATERS

**R. E. Young,¹ F. G. Hochberg, Jr.,²
and R. F. Harman¹**

¹Department of Oceanography
University of Hawaii
Honolulu, Hawaii 96822
and

²Department of Invertebrate Zoology
Santa Barbara Museum of Natural History
Santa Barbara, California 93105

Paralarvae of benthic octopods from Hawaiian waters are characterized. A few benthic species have been identified by rearing the eggs of known adults in the laboratory. Possible identities of some of the remaining species are suggested. Various aspects of the biology of paralarvae are discussed. [Program Summary]

GASTROPOD GUT AND RADULA MORPHOLOGY: EVOLUTIONARY IMPLICATIONS OF A MICRO-COMPUTER ASSISTED STUDY

David R. Lindberg

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The coiling and looping patterns of the gastropod gut and radula, and the numerous character states associated with the radula have been often used to infer relationship between taxa. Results and observations from three current research projects that use characters from the molluscan alimentary system and microcomputer-based analyses are discussed: (1) the construction of phylogenetic hypotheses using phylogenetic inference software (CLINCH, PAUP, PHYLIP), (2) the identification of heterochronic changes in the patellogastropod alimentary system and the use of computer-assisted drawing (CAD) software for anatomical reconstructions, and (3) microcomputer modeling of radular morphology based on the patterns of odontoblast and tooth formation in prosobranch mollusks. Determining the polarity of anatomical characters for phylogenetic analysis can be complicated by the presence of heterochrony in certain organ systems, and can lead to confusion of derived (recapitulated) characters with primitive ones. Moreover, false plesiomorphies are suggested when workers only use characters from the adult mollusk rather than consider the complete ontogeny. For example, both an operculum and epipodial tentacles are present in larval patellogastropods, but the characters are typically scored as absent in this taxon because they are not present in the adult. The alimentary systems of the patellogastropods show increasing juvenilization as one moves from ancestral to derived taxa. This includes fewer loops of the gut and fewer radular teeth. Because the radular sac buds off the stomodaeum early in development, these two compatible character states can be developmentally linked. Patterns of heterochrony in radular morphology were modeled by assuming one tooth per odontoblast, the existence of a single primordial odontoblast, three fields of radular teeth, and simple cell division followed by differentiation based on positional information. All extant radular patterns can be generated by this model using simple assembly rules. Using random variables to determine the number and presence or absence of cell divisions and tooth placement, the ancestral prosobranch radular morphologies (docoglossate, rhipidoglossate) occur with significantly less frequency than the derived types (rachiglossate, taenoglossate).

MULTIVARIATE ANALYSIS OF CHITON VALVE MORPHOLOGY

Douglas J. Eernisse

Friday Harbor Laboratories
Washington 98250

A variety of multivariate methods were used for intra- and interspecific comparisons of valve morphology in the chiton genus *Lepidochitona*. Specific applications of morphometric techniques are presented, using data sets of digitized homologous landmarks. For examining variation within a population, replicated measurements were taken of both the left and right sides of valves 5 and 8 from collection of 60 *L. dentiens* (Gould, 1846) from San Juan Island, Washington. After transforming the data to remove size effects, a 2-way mixed-model ANOVA was performed to estimate variance due to 1) directional asymmetry around a bilateral axis, 2) non-directional asymmetry. For most measurements compared, both directional (favoring the animal's right side) and non-directional asymmetry were found to be significantly greater than expected due to measurement error or random effects alone. Chitons may not be as perfectly bilaterally symmetrical as initially presumed, and individuals differ in observed levels of asymmetry.

As examples of interspecific shape comparisons, data from one side of valve 5 were compared among as many as nine *Lepidochitona* spp., as well as two species in other genera used for outgroup comparisons. A combination of principal component and canonical discriminant analyses of covariance matrices was used. Altogether, 231 animals were collected from different populations in each species' range, and using a variety of morphological and biochemical characters independent of valve shape, were assigned with confidence to a particular species for discriminant analysis. Discrimination between each species was consistently high, and approximately 95 percent of the individuals were classified to the correct group based on comparison of their individual discriminant scores to each group's centroid. Principal component analysis was generally more useful for factoring out size and shape factors with no a priori assumptions concerning group assignment, and indicated that the observed variation among even the most morphologically similar species was due, at least in part, to shape differences.

IN MEMORIAM: ANTONIO J. FERREIRA, M.D.
(1923-1986)

Hans Bertsch

Biological Sciences
National University
Los Angeles, California 90301

Dr. Antonio J. Ferreira was born in Lisbon, Portugal, on 30 July 1923; he died in Los Gatos, California, 19 May 1986. He received his M.D. degree in 1946 from the Faculty of Medicine of the University of Lisbon, Portugal. He immigrated to the United States in 1948, working on the staff of various hospitals in New Jersey and Texas, ultimately completing his psychiatric residency in 1954 at the Veterans' Administration Hospital, Palo Alto, California. Except for 2 years as a Major in the Medical Corps of the U.S. Army, he was in the private practice of psychiatry in San Jose, California, since 1955.

Dr. Ferreira served a year as Director of the Adult and Child Guidance Clinic of Santa Clara County, and was a research or teaching consultant to Agnew State Hospital, Letterman Army Hospital, San Jose State College, the Catholic Social Services, and the Mental Research Institute of Palo Alto. He was a member of the World Federation for Mental Health, American Psychiatric Association, California Medical Association and other professional associations, and an Honorary Fellow of the California State Marriage Counselor Association.

He published 44 papers on various psychiatric topics, was author of the book *Prenatal Environment*, and was co-author of *Research in Family Interaction: Readings and Commentary*.

In the best tradition of international urbanity he enjoyed opera, was a tournament chess player, and a fine pianist. In the early 1970's Tony became interested in the oceans and their molluscan denizens. His first malacological research papers were on nudibranchs, but his interest in chitons (especially with the encouragement of Allyn G. Smith) soon became predominant. His numerous carefully researched, elegantly illustrated and impeccably written publications established him as one of the world's premier authorities on chitons.

He pursued chitons under many of the world's oceans (especially the tropics), with his skill as a scuba diver. I remember one very early morning visit with him (2 a.m.) while he waited to change airplanes in Honolulu for a distant western Pacific island. Tony also meticulously pursued holotypes of chitons at major international museums, obtaining these valuable specimens on loan for comparative study.

Tony was a Research Associate of the departments of invertebrate zoology of the California Academy of Sciences and the Los Angeles County Museum of Natural History. He was also elected a Fellow of the California Academy of Sciences. His personal collection of chitons has been presented to the Department of Invertebrate Zoology and Geology of California Academy of Sciences where it will serve future researchers.

I met Tony shortly after his interest in mollusks had been kindled when I was beginning my graduate studies. Over the years, I spent many evenings with him, his wife Nancy and their three growing children. He was a mentor, but we also learned and discovered together. Although we co-authored several papers on nudibranchs and chitons, we evolved into Socratic gadflies (without the irritation) of each others' work. Many of my papers acknowledge his helpful discussions and criticisms of the manuscript. His universality stimulated me (and others who knew him); our discussions might begin with a biological observation or taxonomic quandry, but would soon include connotations of Latin words, philosophy of science, or some other aspect of global planning. His sharing and prompting of thoughts and ideas are truly cherished gifts. To speak on a most personal level, I am grateful for our many years of friendship: *Atque in perpetuum, frater, ave atque vale*.



Group Photograph, Annual Meeting, 1986

MINUTES
EXECUTIVE BOARD MEETING
Western Society of Malacologists
Monterey, California
1 July 1986

The meeting was called to order by President Gosliner at 10:06 a.m.

Present: Terry Gosliner, Carole Hertz, Matt James, F.G. Hochberg, Margaret Mulliner, Paul Scott, Kirstie Kaiser, Dave Lindberg, George Kennedy (Guests - Vida Kenk, Steve Long, David Mulliner, Jules Hertz).

Secretary's Report: F.G. Hochberg read the minutes from the 1985 Executive Board meeting.

The Secretary indicated that only additions and corrections should be solicited here. A vote of approval is not needed since the minutes are approved by the President and printed in the Annual Report prior to being read at the Executive Board meeting.

Jules Hertz questioned the balance reported in the Treasury. The amount is high because it includes registration income from the 1985 meeting before expenses had been calculated.

Steve Long indicated that postcards were not sent to gratis members of the Society along with the Annual Report as directed by the President in 1985 because enclosures cannot be included in bulk mailings.

Discussion centered around how we track whether gratis copies are being received. The matter was turned over to Vice-President Carole Hertz to resolve.

In the future the Secretary will send out copies of the minutes ahead of the meeting along with the agenda.

Treasurer's Report: Margaret Mulliner presented the Treasurer's report. As of 30 June the Society had a balance of \$4,046.89 in the Treasury (see attached). The Society currently has 158 regular members, 24 families, 7 students, 40 gratis and honorary.

In the future copies of the Treasurer's report will be prepared for distribution at the Executive Board meeting.

Nominations of Officers for 1986-87: President Gosliner presented the slate of officers recommended by William Pitt, Chairman of the Nominating Committee:

President	Carole Hertz
1st Vice President	Matthew James
2nd Vice President	F.G. Hochberg
Secretary	Kirstie Kaiser
Treasurer	Henry Chaney
Members-at-Large	Steve Long, Hans Bertsch

F.G. Hochberg declined the nomination and President Gosliner recommended Hans Bertsch

be moved into this office and that Michael Ghiselin be slated as the Member-at-Large in Bertsch's place.

Both Bertsch and Ghiselin had been approached earlier and had accepted the nominations. Kaiser had not been contacted ahead of time about her nomination but accepted in the Board meeting.

MSP to accept slate of officers as revised.

Annual Report Matters:

1. Editor - Steve Long resigned as Editor on 16 May 1986. Steve Long was praised for producing a timely 1985 Annual Report. The Board stressed again the need to produce the Annual Report in a timely fashion.

President Gosliner announced his intention to appoint Hans Bertsch as Editor for 1986-87.

2. Editorial Review Board - The Editorial Board has been determined to be in violation of the By-Laws. The Editor has the right to choose his own Review Board although if deemed necessary the President has the authority to appoint an *ad hoc* Editorial Review Committee.

Concern was expressed that there continues to be confusion with the procedures and budget for producing the Annual Report.

1987 Meeting: Carole Hertz reported that the 1987 Annual Meeting will be held on 21-25 June on the campus of San Diego State University. It will be the 20th Annual meeting of the Western Society of Malacologists. The costs for housing, meals and parking will be approximately \$30.00/day. Evening meals will be held in the Faculty Club. The Banquet will be catered by the University.

Judy Terry-Smith will coordinate a Symposium on "The Imperial Formation and the Northern Gulf of California - its Geology and Recent Mollusca." David Leighton has been approached about organizing a second symposium on the "Aquaculture of Mollusks."

Student Grants: Vida Kenk reviewed the 1985 grant selection process. Over 250 announcements were mailed to western states only. Committee costs were about \$100.00.

Twenty four applications were received and reviewed by the grant committee. Number and quality of applications up from previous years. Two awards were presented:

WSM - Ken Leonard (University of Washington)
SWMS - Janis Bell (University of Hawaii)

MSP to offer a WSM Student Grant in 1987.

Considerable discussion ensued with regard to

the monetary amount of the grant. Considering the state of the budget it was proposed to reduce the amount from \$750.00 to \$500.00. When questioned whether this was adequate to accomplish research, Kenk responded that it was an appropriate amount. Gosliner expressed concerns that by reducing the amount of the grant we do not want to jeopardize the numbers of applications nor the quality. According to Carol Skoglund it is doubtful if the matching grant provided by the Southwest Malacological Society and administered by WSM as part of this program will be present in the future.

MSP to allocate \$500.00 for the 1987 Student Grant.

Scott stressed that one of the most significant activities of the WSM is the support of students through grants. WSM should strive to raise the amounts of this grant whenever possible and not lower it.

Question was raised concerning what WSM receives in return for grants. Kenk commented that students file a report of their work in the summer of year following receipt of grant. However, we do not track publications, theses and dissertations which acknowledge help from grants. Kenk will attempt to track this information and will add a statement to this effect on the application form. In addition, Kenk will revise and computerize mailing list. It was stressed that WSM should advertise nationally to attract applications from the best students.

MSP to increase mailings in order to advertise the WSM student grant nationally.

The Editor was directed to list other sources of student grants in the Annual Report.

Best Student Paper Awards: Hochberg announced the winners of the 1985 Best Student Papers:

1. Sally Walker (University of California, Berkeley)
2. Tim Pearce (University of California, Berkeley)
3. Peter La Rochelle (University of Colorado)

The First Place is awarded a 2-year membership in WSM and a complete set of the back issues of the Annual Report. The Second and Third Places are awarded a 1-year membership and a complete set of the Annual Report.

Hochberg indicated in the future these awards should be listed in the minutes of the Annual Business Meeting.

MSP to present a single Best Student Paper Award at each Annual meeting.

MSP to direct the President to establish each year an hoc committee to handle this responsibility at the Annual meeting.

Preliminary Budget for 1986:

A. Annual Report - Considerable concern was expressed with the quality of the 1985 Annual Re-

port. Secondly, it does not appear to be clear what the function and value of the Annual Report is or should be. Is it the Society's principal organ which needs to be well done to attract members or is it simply a vehicle for dissemination of abstracts much like a meeting program? Steve Long estimated it would cost \$2000.00 to publish the Annual Report with a higher quality paper stock.

MSP to allocate an amount not to exceed \$1800.00 for production of the 1986 Annual Report.

B. Annual Meeting Expenses - Gosliner reviewed the history and problems involved in sharing costs with AMU for the 1986 Annual meeting. AMU did financial planning and calculated registration fees well ahead of time. Some expenses were not budgeted for, such as refreshments, etc. Cost overruns are estimated to be \$2000.00. If we are truly a co-sponsor we have an obligation to meet some of these expenses.

The Executive Board was polled concerning this matter in June. Mulliner pointed out that this ballot was in violation of the By-Laws since the Audit Committee had not approved an outlay of expenses for the 1986 joint annual meeting.

Audit committee expressed concern that if we can't afford to raise or even maintain the level of funding for the Student Grant, why pay for coffee and donuts and Best Student Paper Award?

J. Hertz indicated that the trends in auditing show a decreasing balance due to increased expenses. When combined with a decline in income from auctions, we can't build the budget. In addition, WSM is losing members through non-renewals and is not getting new members. With an operating budget about \$2000.00 and interest rates dropping the Society may experience cash flow problems.

Meeting recessed at 12:20 pm to allow audit committee to meet.

Meeting was reconvened at 12:40 pm.

Audit committee reported that the ballot seeks to spend half of the \$2200 remaining in the budget. However, up to \$1500 is due in January for the 1987 annual meeting. Hence, the committee recommended only spending \$400.00 to help defray the cost overruns of the 1986 AMU/WSM meeting.

Hochberg raised a point of order whether the committee could specify how the money was spent or only recommend the amount to be spent. Hochberg and Kaiser expressed concern that the money should be spent for a Student Award and that the cost overruns should be borne by AMU.

After considerable discussion the Board accepted the Audit Committee's recommendation.

MSP to direct the Treasurer to provide \$400.00 to AMU to help cover the cost of hospitality at the 1986 joint annual meeting.

Hochberg stressed that the viability of the Society depended on developing realistic long range plans

to help define goals and determine future directions.

OTHER BUSINESS

1. **Officer's Manual:** Kennedy has revised and updated the old Officer's Manual but was not able to provide copies due to computer problems. These will be sent out at a later date once they have been checked against the By-Laws.

2. **Historian:** Hochberg announced that the Historian, Jody Woolsey, resigned as of 2 June 1986. The President will appoint a new one at the Annual Business meeting. There was some discussion as to the duties of the Historian and the need to store the Society's historical notebooks.

3. **WSM Archives:** Hochberg offered to house the archives at the Santa Barbara Museum of Natural History.

MSP to accept the Santa Barbara Museum of Natural History as the official WSM archive.

All items pertaining to the history of the Society such as correspondence, minutes of meetings, annual meeting information, back issues of the Annual Report, historical notebooks, are to be sent to the Museum.

Mulliner indicated that old AMU/PD history notebook was to Philadelphia where the AMU archive is located.

4. **Sale of Shell Display Cases:** Gosliner indicated that the three table top display cases which were listed for sale by silent auction in 1983 have still not been sold. He noted that two of these cases would be offered for sale during the auction on the condition that they are to be removed at the expense of the buyer.

5. **Bishop Museum Resolution:** Gosliner reported that he had received two responses to his letter of 4 November 1985 which contained a \$500.00 donation to the Bishop Museum (see Resolution, 1985 minutes). Letters were received from the Chairman of the Board of Trustees of the Bishop Museum and the Honolulu Star Bulletin. Nothing was published in the newspaper nor was the use of the money tracked.

6. **1989 AMU Meeting:** Gosliner reported that Jim McLean will be president of AMU in 1989 and that, consequently, the AMU meeting will be held in Los Angeles. McLean has extended a formal invitation to WSM to meet jointly in 1989 (see attached letter).

Hans Bertsch, as nominee for the 1989 WSM President, has indicated that he would accept the position of a joint host for this meeting.

MSP that the WSM hold a joint meeting with AMU in 1989 pending approval by vote of the entire WSM membership.

Secretary Hochberg was directed to prepare a mail ballot with background information. The wording is to be approved by T. Gosliner, C. Hertz and H. Bertsch before the ballot is submitted to the members.

Kennedy stressed the need to appoint an Ad Hoc liaison committee for this meeting.

7. **1988 Annual Meeting:** James indicated that the 1988 meeting will be held in northern California or Oregon. He is currently looking at possible meeting sites.

8. **Business Meeting:** The location and time of the Business meeting was discussed. There was some concern that it conflicted with the auction by providing time constraints to those people who wanted to preview items for sale before the auction began.

The Business Meeting agenda was approved.

There being no further business, the meeting was adjourned at 1:35 pm.

These minutes were respectfully submitted by:

F.G. Hochberg, *Secretary*,

and approved by Terrence Gosliner,
President (1985-86).

EDITOR'S NOTE: The following recent publication acknowledges funding assistance from the Western Society of Malacologists:

Lohmann, Kenneth J., and A.O. Dennis Willows.
1987. Lunar modulated geomagnetic orientation by a marine mollusk. *Science* 235 (4786): 331-334.

The Society congratulates Mr. Lohmann on his research and its publication in the prestigious journal of the American Association for the Advancement of Science.

ERRATUM: In Volume 18 of the Western Society of Malacologists, Annual Report, the title of the article by Gosliner, Johnson and Bertsch (p. 14) was erroneous. Please correct the title to read: "Additions to the Opisthobranch Gastropod Fauna of the Hawaiian Islands."

Period covering 1 November 1985 to 30 June 1986

Balance at beginning of period				\$5500.98
Dues:				
1986	158	7.50 (reg.)	\$1185.00	
Family	24	1.00	24.00	
Student	7	3.00	21.00	\$1230.00
1984	9	7.50	67.50	
1985	13	7.50	97.50	
1987	1	7.50	7.50	172.50
Refund from Santa Barbara Club for W/C reception			200.00	
Publications			16.00	
Student Grant Fund (donations)			240.50	
S/A interest 11/30/85 to 5/31/1986			120.92	577.42
				Income
				Expense
				<u>4046.89</u>

Treasurer	\$ 145.17	
President	115.00	
Student Grant	750.00	
Donation to Bishop Museum	500.00	
COA dues	7.50	
AMU dues	22.00	
Secty of State	2.50	
Conference 1985 (Late bill)	111.07	
Editor - Advance toward A.R. Vol. 18	500.00	
Balance of cost	1130.66	
New membership cards	150.11	
		Total
		\$3434.01

ANNUAL BUSINESS MEETING
Western Society of Malacologists
Monterey, California
4 July 1986

The meeting was called to order by President T. Gosliner at 7:03 pm.

Present: 28 members

Secretary's Report: Secretary Hochberg summarized the minutes of the 1985 Annual Business Meeting.

MSP to accept the minutes as summarized.

Treasurer's Report: M. Mulliner presented the Treasurer's report for the period 18 August 1985 to 30 June 1986.

MSP to accept the report as presented.

Appointments: President Gosliner made the following appointments:

Editor (1986 Annual Report): Hans Bertsch

Mentor/Parliamentarian: Eugene Coan

Historian: Barbara Chaney

Standing Committees

Nominating: Terrence Gosliner (Chair),

William Pitt, George Kennedy

Audit: F.G. Hochberg (Chair),

Paul Scott, Dave Mulliner

Ad Hoc Committees

Student Grant: Vida Kenk (Chair), Eugen Coan,

James Nybakken, Judy Terry-Smith, Terrence Gosliner

Student Best Paper Award

(1986 Annual Meeting): Michael Ghiselin,

Paul Scott

Election of Officers: In the absence of W. Pitt, Chair of the Nominating Committee, President Gosliner presented the following slate of officers:

President Carole Hertz

1st Vice President Matthew James

2nd Vice President Hans Bertsch

Secretary Kirstie Kaiser

Treasurer Henry Chaney

Members-at-Large Steve Long,
Michael Ghiselin

MSP to close nominations.

MSP to cast unanimous ballot for slate of officers as presented.

New Business

1. **1987 Annual Meeting:** Carole Hertz announced that next year's annual meeting would be held in southern California from 21-25 June on the campus of San Diego State University. Judy Terry-Smith will organize and chair a Symposium on "The Imperial Formation and the Northern Gulf of California - its Geology and Recent Molluscs."

2. **Bishop Museum Resolution:** President Gosliner reported that letters concerning the WSM resolution (see 1985 minutes) were sent to the Director and Chairman of the Board of Trustees of the Bishop Museum and to the Editors of two Hono-

lulu newspapers. Responses were received from Edwin L. Carter, Chairman of the Board of the Bishop Museum, and from the Honolulu Star Bulletin. There was no response from Donald Duckworth, Director of the Museum.

D. Shasky questioned whether money had been spent on collections. T. Burch commented that the money may have been placed into a fund to pay the Invertebrate Zoology department assistant. He will check.

3. **Auction of Shell Cases:** Two of the three display cases originally stored at Asilomar will be offered at the auction tonight. If purchased they have to be removed at the buyer's expense.

4. **Student Best Paper Awards:** Secretary Hochberg announced that in 1985 awards for Best Student papers were presented to:

1st Sally Walker (University of California, Berkeley)

2nd Timothy Pearce (University of California, Berkeley)

3rd Peter La Rochelle (University of Colorado)
The 1986 Best Student Paper Award was won by Janet Voight (University of Arizona, Tucson).

5. **Annual Dues:** President Gosliner conveyed an Executive Board recommendation that WSM dues should be increased starting in 1987. Dues have not been raised in more than 10 years. The costs of operating the Society are continually going up and the balance in the treasury going down.

MSP to raise dues starting in January 1987 to

\$10.00 regular members

\$12.00 family

\$ 4.00 student.

D. Shasky questioned how much the increase will add to the Society's operating income. At the level of current membership numbers it would generate about \$400.00 additional income. T. Gosliner stressed the need to send in dues in a timely fashion in order to meet the Society's financial obligations.

6. **Life Memberships:** The Executive Board was directed to explore the advantages of life memberships. P. Skoglund stressed the need to consider the disadvantages of life membership in order not to jeopardize the continued receipt of operating income from regular membership dues.

The institution of a new membership category would require a change in the By-Laws. In order to enable such a recommendation, the changes should be circulated to the membership early in the year so it can be approved at next year's meeting.

7. **1988 Annual Meeting:** Matt James indicated it will be held in northern California or Oregon at a site still to be selected.
8. **1989 AMU Meeting:** President Gosliner announced that the 1989 AMU meeting will be held in Los Angeles. Jim McLean will host the meeting and has formally invited WSM to participate as a co-host.

The Secretary has been directed to poll the WSM membership by mail to ascertain if this is acceptable.

D. Shasky recommended appointing an ad hoc committee to begin to deal with the joint meeting. T. Gosliner, G. Kennedy and F. G. Hochberg agreed to serve on this committee.

Considerable discussion ensued concerning the advantages and disadvantages of a joint meeting. It was stressed that if the meeting was to be truly a joint venture WSM needs to share in planning of the meeting from the beginning. Do the advantages of holding a joint meeting outweigh loss of income? It was stressed by several members that exposure at joint meetings is especially critical for students and professionals. By starting to work early it will be possible to have a very successful joint venture.

Although the Monterey meeting was billed as a joint meeting, WSM was not given equal billing. Small but sensitive issues (such as name tags) remain as a continual source of irritation.

Hans Bertsch requested written comments with specific complaints about the meeting be sent directly to him. J. McLean is sensitive to the issue and with Bertsch in Los Angeles there should be no problem organizing a successful joint meeting if approved by the membership.

S. Long addressed the issue of auction economics. He noted the trend that fewer duplicates of both books and shells are available today. Is this a real

issue or is it a function of joint meetings or a function of not getting out a call for auction items?

9. **Annual Report:** All WSM members who attend the meeting will be able to publish abstracts in both the AMU Bulletin and the WSM Annual Report.

Modified or extended abstracts need to be submitted to the Editor Bertsch by **15 August**. Abstracts should reflect information as presented at the meeting rather than what was submitted prior to the meeting.

Bertsch explained that the AMU By-Laws stipulate that anyone who presented a paper at an AMU meeting was required to submit an abstract to the AMU Bulletin and pay \$15.00 toward page charges. Only students and symposium speakers are exempt.

D. Shasky suggested that a key to heteropods would be a welcome addition to the Annual Report. Hochberg will solicit a manuscript from Roger Seapy.

10. **Closing Comments:** President Gosliner extended his thanks to all the outgoing officers, especially to the Treasurer, M. Mulliner, for her long years of service and to the Editor, S. Long, for promptly producing the Annual Report. He additionally thanked all the hosts, organizers and all the people involved with the meeting.

He then turned the gavel over to President elect C. Hertz.

There being no further business the meeting was adjourned at 8:07.

These minutes were respectfully submitted by:

F.G. Hochberg, *Secretary*,
and approved by Terrence Gosliner,
President (1985-86).

ANNOUNCEMENTS OF FUTURE MEETINGS

The 20th Annual Meeting of the Western Society of Malacologists will be held 21-25 June 1987 on the campus of the San Diego State University. The W.S.M. program will include the annual shell auction, reprint exchange, exhibits, symposia on "The Imperial Formation and the Northern Gulf of California—Its Geology and Recent Mollusca," and "Molluscan Aquaculture." Advance registration is

strongly encouraged: Carole M. Hertz, President W.S.M., Dept. of Marine Invertebrates, San Diego Natural History Museum, P.O. Box 1390, San Diego, California 92112.

The 21st Annual Meeting will be held in 1988 in northern California or Oregon. Contact Dr. Matthew J. James, Dept. of Geology, Sonoma State University, Rohnert Park, California 94928.

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Audit:

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Paul Scott
David Mulliner

Ad Hoc Committees

Student Grant

Dr. Vida Kenk
Eugene Coan
James Nybakken
Terrence Gosliner
Judith Terry Smith

Student Best Paper Award

Dr. Michael T. Ghiselin
Paul Scott

Liaison for 1989 Joint WSM/AMU Meeting

Dr. Terrence M. Gosliner
Dr. George L. Kennedy
Dr. F.G. Hochberg

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David Mulliner	1967-1968
William K. Emerson	1968-1969
A. Myra Keen	1969-1970*
Eugene V. Coan	1970-1971
Beatrice L. Burch	1971-1972
Twila Bratcher	1972-1973
James H. McLean	1973-1974
George Radwin	1974-1975*
James Nybakken	1975-1976
Helen DuShane	1976-1977
Peter D'Eliscu	1977-1978
Barry Roth	1978-1979
Vida C. Kenk	1979-1980
Carol C. Skoglund	1980-1981
Donald R. Shasky	1981-1982
David R. Lindberg	1982-1983
George L. Kennedy	1983-1984
William D. Pitt	1984-1985
Terrence M. Gosliner	1985-1986

*Deceased

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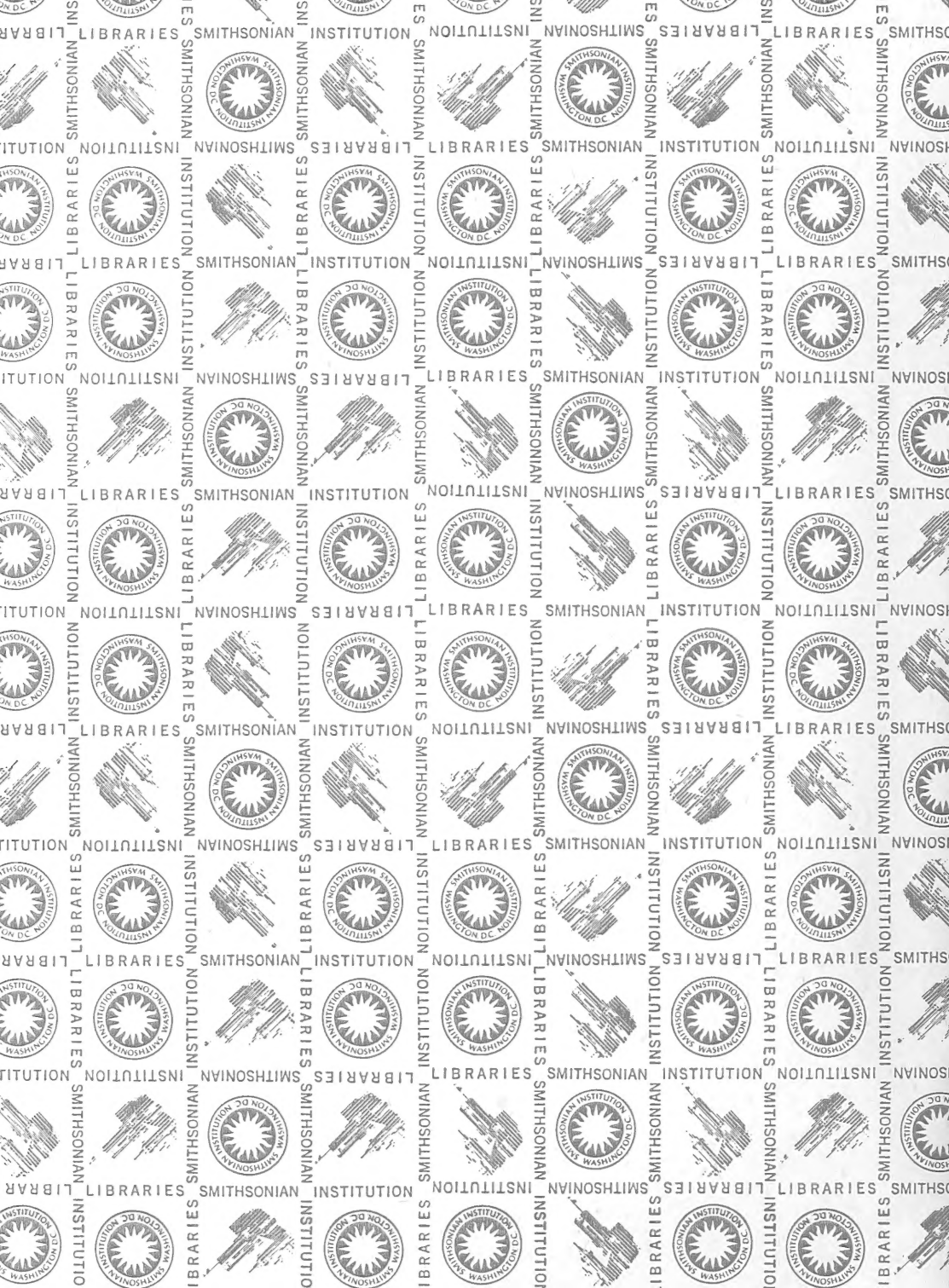
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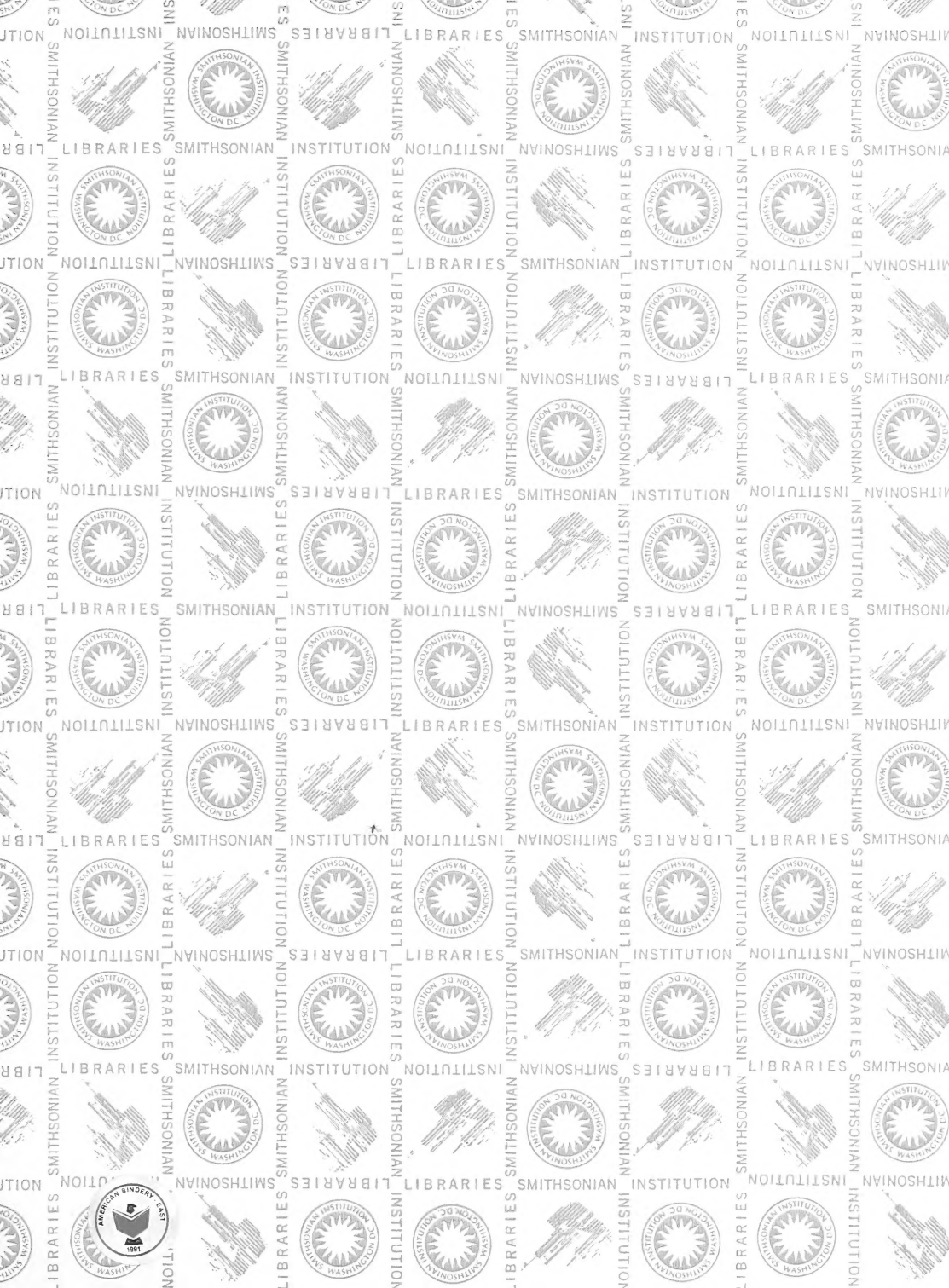
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